1874

AN
ESSAY
ON THE
POWERS AND MECHANISM
OF
NATURE;

INTENDED,

By a Deeper Analyſis of PHYSICAL PRINCIPLES,

To extend, improve, and more firmly eſtabliſh,

The GRAND SUPERSTRUCTURE of the

NEWTONIAN SYSTEM.

By *ROBERT YOUNG.*

K.

LONDON:
PRINTED FOR THE AUTHOR,
By FRY and COUCHMAN, near Upper-Moorfields;
And ſold by T. BECKET, Pall-Mall; J. JOHNSON, St. Paul's-Church-Yard; and J. MURRAY, Fleet-Street.
M DCC LXXXVIII.

BRITISH MUSEUM

PREFACE.

BY the Newtonian ſyſtem, I mean the ſyſtem of the world diſcovered by Pythagoras, revived by Copernicus, and, by the aid of a ſublime and exquiſite geometry, brought to its preſent ſtate of perfection by Sir Iſaac Newton. In this acceptation of the term, the following Eſſay is intended to ſupport, extend, and improve the Newtonian ſyſtem. But to do this, by no means implies an implicit attachment to every doctrine adopted in that ſyſtem. On the contrary, improvements imply imperfection, and imperfection error. The phyſical parts of the Newtonian ſyſtem are allowed, by its moſt learned and judicious friends, to want thoſe traces of the great maſter that diſtinguiſh the mathematical principles.

Sir Iſaac himſelf appeared ſenſible of their imperfection, and ſeemed to leave them to the correction of others, when he denominated his work mathematical principles, thereby leaving out the phyſical, as forming, in his opinion, a leſs perfect part of his ſyſtem, on which he did not chooſe to commit his fame.

In reforming theſe, or attempting to do it, I think, far from oppoſing Sir Iſaac, I am an humble coadjutor in his labours, by inveſtigating, anew, thoſe difficult points, in reſpect to which he candidly acknowledged his defects, and called upon the new exertions of his readers to ſupply them. Nor is it, truly, to honour the memory of this great man, with a ſuperſtitious veneration to receive, as ſacred, all his opinions, and thus hand down his errors, uncorrected, to poſterity, to the injury of his reputation when a greater lapſe of time ſhall place mankind in a condition to diſcriminate more juſtly of his labours. Thoſe, rather, may be called his friends, who, by expunging what is erroneous in his works, leave that which remains more perfect; and by ſupplying the defects of his ſyſtem, tranſmit it more complete to future times, a more glorious monument of his fame.

The following Eſſay is intended to improve the phyſical principles of philoſophy, in order to extend our knowledge of nature. If I have ſucceeded in theſe views it will be no objection to my attempt that I have deviated from principles already eſtabliſhed, ſince it is obvious that every advance in knowledge implies the diſcovery and renunciation of ſome error. He, who will adhere immutably to tenets once adopted, can never increaſe his light, nor improve his underſtanding.

Nor will any, who think juſtly, be offended, either that their own opinions are controverted, or that too little regard is paid to the authorities they have been accuſtomed to reſpect. They will know, that while our knowledge remains imperfect, our opinions muſt be mingled with errors, and that thoſe errors muſt have the ſanction of the learned, who dictate opinions. They will pay the tribute due to the talents of every man, without yielding a ſlaviſh obedience to any. They will regard the inward conviction of the mind, as an authority ſuperior to the concurring ſentiments of the age; nor will they ſurrender up their own underſtanding to that of another, whatever be his talents or his name.

It is the more neceſſary to inſiſt on the liberty of reaſon, in matters of ſcience, when we find that liberty in danger from the zeal with which ſome endeavour to defend the opinions they have adopted; and when language and ſentiments like theſe are diſſeminated in philoſophical works;

" Sir Iſacc Newton is the perſon to whom
" we owe theſe obligations, and who is
" hence-

“ henceforth to be conſidered *as our only* “ *ſure guide and inſtructor*;” and again, “ Newton has diſcovered the chaos, and “ ſeparated the light from the darkneſs. “ His inimitable work, the mathematical “ principles of natural philoſophy, con- “ tains *the true aſtronomical faith: and* “ *thoſe who reject its doctrines, are the* “ *worſt of heretics*; as they ſhut their “ eyes againſt the cleareſt of all light, “ demonſtration[a].”

Surely, when implicit faith in any human authority is thus required of us, it is time we ſhould diſpute, if not becauſe we doubt, to aſſert, at leaſt, the freedom of the mind, and preſerve the right of doubting.

More congenial with the ſpirit of ſcience are ſentiments, which, as delivered by a reſpectable advocate for the principles of Sir Iſaac Newton, I avail myſelf of, as a complete apology for my preſent undertaking, if any apology were wanting;

---

[a] Bonnycaſtle's Introduction to Aſtronomy.

Mr. Maclaurin ſays, "We often obtain "this advantage from diſputes concerning "the elementary principles of any ſcience, "that they are the more carefully inquired "into, and when found juſt, are illuſtrated, "and *the better underſtood for having been* "*diſputed*[b]." The ſame gentleman, ſpeaking of certain tenets, held by thoſe who oppoſed the Newtonian ſyſtem, ſays, "If "thoſe tenets be true, they will be con"firmed by our inquiries; and if they "be falſe, ſurely, it is better they ſhould "be detected[c]."

And is not the ſame to be ſaid of all principles and doctrines? If they be true, they will be confirmed by our inquiries; and if falſe, ſurely, it is better their fallacy ſhould be detected.

---

[b] Maclaurin's Account of Sir ISAAC NEWTON's Diſcoveries, page 151.

[c] Page 5.

It is acknowledged by all, that much obſcurity and difficulty hath ever attended the ſubject of the following diſquiſitions. It is by freedom of inveſtigation alone, that we can hope to make advances in the inquiry. The voyager, who confines himſelf to a long accuſtomed tract, can have no proſpect of making diſcoveries. I hope others will follow my example, and that this important ſubject will be brought forward into a full diſcuſſion. And if I ſhall be found to have erred in my attempt, I ſhall yet be confeſſed to have rendered ſome ſervice to ſcience, if what I have done ſhould be the means of inciting others to more ſucceſsful endeavours.

As, in practice, nothing is perfect, and few things wholly without merit; ſo, in theories, perhaps none are without error, nor any devoid of truth. The difference between opinions, ſeems to lay chiefly in the different proportions of truth and error which they contain. If this be true, every advance in principles is only ſubſtituting a leſs imperfect theory for one more ſo, and the laſt, ever leaves ſomething for futurity to correct.

Some readers may be deſirous to find a name for the following work, by obſerving to what ſyſtem, ancient or modern, it moſt adheres, or is moſt reſembled: for myſelf, I can aſſure them I did not ſeek for it, nor find it, in books, but in the reflections of my own mind alone.

Many will object to the method of reaſoning herein followed, that philoſophy has only to collect general laws from phenomena, and then apply thoſe laws to the explanation of other phenomena; and has no concern with metaphyſics. To this I anſwer, that the preſent is a phyſical, and not a metaphyſical work, if metaphyſics *are* to be loaded with an unmerited opprobium; that the object of my inquiry is not facts but powers, not effects but cauſes; that the received theory doth not, agreeably to its profeſſions, confine itſelf to the aſſertion of phenomena, but aſſumes, as cauſes, phyſical principles, which are not matters of fact, nor laws collected by induction, but which are to be examined by phyſical reaſoning alone. Theſe principles, thus aſſumed in the received theory I have not adopted, and therefore it became neceſſary to ſubſtitute others in their place, and to this end I have employed the following pages. I have not attempted it by means of experiments, becauſe they can diſcover effects only, and not cauſes, which I ſought; nor by geometry, becauſe it is concerned only with relations of quantity, and cannot lead to the knowledge of being or of power.

By phyſical reaſoning alone, I have found a phyſical principle, adequate to the purpoſes of explaining phenomena. A ſubſtance actually exiſting, poſſeſſed of active powers, the baſis of matter itſelf, and the agent in all effects. This active ſubſtance appears to have been the deſideratum in all ages of philoſophy. It removes the obſcurity which attends the conſideration of matter as an original and inactive ſubſtance, whoſe eſſence, ſolidity, is confeſſed to be incomprehenſible ; it removes the difficulty which has ever attended the queſtion of the origin of motion, by ſhowing motion to be the original form of being ; and thus reflects a light upon the very foundations of ſcience.

If, in this purſuit, I have been obliged to throw down ſome barriers of ancient opinions, I hope the ſucceſs will repay the ſacrifice. That matter was an inactive and impenetrable eſſence, was an error of early date. Led away by this, Sir Iſaac Newton was obliged to frame ſuch principles as were agreeable thereto, and the ſecond error was a conſequence of the firſt. He aſcribed to matter a quality, till his time unthought of, an inherent power of perſevering in its proper ſtate of reſt, or uniform rectilineal motion. A principle, the importance, novelty, and ſingularity of which, entitled it to a more cautious ſcrutiny than it ſeems to have met with. It *begged the queſtion*, long diſputed, by what cauſe motion was continued, averring, but without proof, that it was by a force innate in bodies. This principle being only intended to explain the perſeverance in one ſtate, required another to account for changes of the ſtate of bodies from motion to reſt, or from reſt to motion.

A name was given to this, *impreſſed force*, but no explanation given of its nature, ſeat, or origin. The objections to theſe principles are many and unanſwerable. They are wholly deſtitute of proof; they are far from being evident in themſelves, otherwiſe, how were they ſo long unknown. They preſent no clear idea to the mind, and want that preciſion ſo requiſite in firſt principles. The *vis inertiæ* has a contrariety of nature that perplexes the underſtanding. It has no decided character, is neither motive nor quieſcent; but alternately and indifferently both; by being too much, it becomes nothing; by uniting two contraries it deſtroys both. The *vis impreſſa* hath no clear idea annexed to it, neither as a ſubſtance nor a quality; it hath no intelligible mode of operating; it acts, and ceaſes to act, in a manner equally inconceivable.

Wanting ſimplicity, clearneſs, and conſiſtency, theſe principles afford very little ſatisfaction to the mind; wanting proof or evidence, they have no other claim to our acceptance, than the authority of their author, which hath too long, already, preſerved their credit with the world. So long as we conceived matter to be impenetrable, and endowed with a power of perſevering at reſt or in motion, it appeared to me, that no true or ſatisfactory principle could be diſcovered for the explanation of effects. It was neceſſary to get rid of theſe before others could be ſubſtituted in their room.

For this reaſon I publiſhed, ſome time ago, an examination of the phyſical principles of the received ſyſtem[d], wherein I ſhowed their error, independent of any view to ſubſtituting another theory in their ſtead. Their error was evident from the contradictions they appeared to involve; they were ſhown to be inſufficient to explain phenomena; and it is, then, of little conſequence to allege their defect of proof. It was impoſſible, in this matter, to pay regard to the prevailing prejudices of the day, without ſacrificing the more important intereſts of truth. By ſhowing the inſufficiency of received principles, I intended to open the way to new diſquiſitions upon the ſubject; and ſuch an one I here ſubmit to the learned.

Had I delayed the preſent work ſome time longer, I might have corrected many of its faults, and conſulted my own reputation more; but other avocations required me to diſmiſs the preſent: and I hoped this great advantage would ariſe from its early publication, that others would be the ſooner induced to proſecute ſo important and extenſive an inquiry, in the ſame method. I have chiefly confined myſelf, in this volume, to the inveſtigation of general principles, and hope, in a future work, to proſecute further, ſome particular applications to phenomena.

---

[d] Entitled, An Examination of the Third and Fourth Definitions of Sir Isaac Newton's Principia, and of his Three Laws of Motion.

On a ſubject ſo difficult, treated in a method in which I had no guide nor aſſiſtance from others, I hope much indulgence will be granted me, and I am conſcious that I ſtand much in need of indulgence. I requeſt that the reader will diſtinguiſh between the defects of the author's abilities and the faults of his principles. Many truths he may find not explained in the beſt poſſible manner, nor ſupported by the moſt cogent proofs. In ſupplying ſuch defects, and correcting what errors I may have fallen into, there will be ſufficient exerciſe for the talents, and the good nature of thoſe who chooſe to undertake theſe taſks.

DEFINITIONS.

ACTION. THE production, or prevention of any change.

ACTIVITY. Diſpoſition to motion.

AGENT. A being which acts.

ATTRIBUTE. That which exiſts in another and not of itſelf.

CAUSE. That which produceth an effect.

EFFECT. That which is produced by another.

MATTER. A being whoſe parts reſiſt penetration or ſeparation.

MOTION. Change of place.

POWER. Ability to act.

RESISTENCE. Counter action.

CONTENTS.

PART I.

Analyſis of Matter and Motion.

INTRODUCTION ....Page 1

CHAP. I. *Analyſis of Matter in general*......p. 8

CHAP. II. *Analyſis of Atoms, or Primary Parts,* p. 23

CHAP. III. *Error of the Doctrine of Impenetrability,* p. 31

CHAP. IV. *Analyſis of Motion*.............p. 45

CHAP. V. *Action is an Attribute of an Active Subſtance*..............................p. 57

CHAP. VI. *On the Exiſtence of an external, unintelligent Agent, with a Review of ſeveral Opinions,*

Opinions, particularly that of BERKLEY, *on the Subject* .... p. 63

CHAP. VII. *The* ACTIVE SUBSTANCE *an immaterial Exiſtence, not Mind, but intermediate, and related to Matter and Mind* .... p. 84

PART II.

Of Action, and the Manner in which the ACTIVE SUBSTANCE *produces Matter and Motion, inveſtigated by Inferences from Effects to Cauſes.*

INTRODUCTION .... Page 89

CHAP. I. *On the Rules of Reaſoning from Effects to their Cauſe* .... p. 91

CHAP. II. *In what Manner the* ACTIVE SUBSTANCE *is active, and how it acts* .... p. 104

CHAP. III. *On the different Origins and Circumſtances of Activity in Bodies, apparent from Obſervation* .... p. 108

CHAP. IV.

CHAP. IV. *Of Activity in the General, conſidered as appertaining to Bodies* .... p. 113

CHAP. V. *Of Activity in Bodies, as diſtinguiſhed into Motion and the two Forms of Impulſe, Preſſure and Percuſſion* .... p. 122

CHAP. VI. *Of the Production of Matter from its immaterial Elements* .... p. 147

CHAP. VII. *Of the Conſtructive Analogy between the Primary Corpuſcles, the Planets with their Syſtems, the Solar Syſtem, and the Fixed Stars,* p. 193

PART III.

A further Inveſtigation of the Nature and Laws of the ACTIVE *or* ELEMENTARY SUBSTANCE.

CHAP. I. *Origin of the Phyſical Power, exemplified in Elaſtic Bodies, Inflammable Bodies, Chemical Operations, Living Proceſſes, and Gravity* ....Page 215

CHAP. II.

CHAP. II. *Origin of Motion* .... p. 222

CHAP. III. *Origin of the Orbicular Motions, which the* ACTIVE *or* ELEMENTARY SUBSTANCE *aſſumes, as the conſtructive Principle of Nature; and the Laws of the Elementary Subſtance,* p. 233

CHAP. IV. *The Mechaniſm of Coheſion, and the connecting Corpuſcles* .... p. 247

CHAP. V. *Of the Orbicular Motion of the* ACTIVE SUBSTANCE *in Mechanical Impulſe* ...... p. 257

CHAP. VI. *Abſurdity implied in the Queſtion concerning the Origin of Motion* .... p. 263

CHAP. VII. *Law of Union, in what Reſpects agreeing with the Attraction of the Newtonian Philoſophy, and wherein diſtinguiſhed from it,* p. 268

PART IV.

Some Abridgement of the foregoing Ideas; their Agreement with Facts: Concluſion.

CHAP. I. *Conſtitution of the Univerſe*, Page 273

CHAP. II. *Agreement of Phenomena with the Theory*.................................p. 283

CHAP. III. *Agreement of Phenomena, with the Orbicular or Revolving Motion, of the* ACTIVE SUBSTANCE, *which is the Conſtructive Principle throughout Nature*.................. p. 308

CHAP. IV. *Select Propoſitions, abridged from the foregoing Pages, and ſeparated from their Proofs*, p. 322

CONCLUSION......................... p. 331

ERRATA.

Page 46, *line* 12, *for* in, *read* is.
—— 58, — 10, *for* action, *read* to act.
—— 150, — 7, *for* and, *read* or.
—— 291, — 17, *for* action, *read* re-action.
—— 306, — 4, *for* double, *read* quadruple.

I beg leave, in this place, to correct an error in my former work, *An Examination of the Third and Fourth Definitions of Sir* ISAAC NEWTON's *Principia, &c.* where, ſpeaking of a horſe drawing a ſtone, I ſay, "The ſtone doth not re-act, becauſe "it doth not act; it reſiſts, but reſiſtence is not action." Page 31.

It is uſual with authors to aſcribe the difficulty of moving bodies to a reſiſtence of the bodies; and I incautiouſly, from habit, fell into this error, although I had, before, corrected it in myſelf. My miſtake lay, firſt, in admitting that bodies, at reſt, independent of friction or media, *reſiſt*; and I was then led to the inconſiſtency of denying reſiſtence to be action. But the difficulty experienced in moving a body, doth not proceed from a reſiſtence of the body: a body is not moved without an adequate cauſe; and the difficulty lies in imparting that cauſe to the inactive matter, not in any reſiſtence it oppoſes to being moved.

AN ESSAY, &c.

PART I.

Analyſis of Matter and Motion.

INTRODUCTION.

THE firſt part of the buſineſs of Philoſophy is to ſeek for principles, the next, is to apply them to the explanation of natural appearances. Principles are diſtinguiſhable into two kinds, EXPERIMENTAL and RATIONAL; The experimental, are general facts, which, being found uniformly to obtain, ſo far as obſervation has gone, are confided in, as conſtant, and referred to as DATA, by which to explain other leſs general facts which they involve. Rational principles are conceptions of the underſtanding, whoſe evidence reſts not alone on experiment, but on intuitive perceptions.

B To obtain the former ſort of principles, we muſt make obſervations of facts; to arrive at the latter, we muſt exerciſe our intellectual faculties.

C Powers and primary cauſes are objects of the underſtanding alone. Some have erroneouſly conceived, that ultimate cauſes lay concealed in the minute parts of matter, and eſcaped us only by their diminiſhed magnitude, and imagined that finer organs are all that is wanting to their diſcovery. But this is not the caſe: ultimate principles cannot be ſubjected to the examination of our ſenſes, becauſe every perception of ſenſe is an effect of thoſe principles, and preſuppoſes them. Theſe, therefore, are not to be ſought by experiment, but inveſtigated by reaſon.

D Among rational principles, or truths intuitively perceived, we are not to chooſe at random or by gueſs, ſome one for the baſis of a philoſophical ſyſtem. For out of a multitude of truths, equally certain, how ſhall we aſcertain thoſe which will ſerve to explain the greater number of phenomena?

E Des Cartes appears to have erred in the method he took to eſtabliſh his rational principles. He ſought, among the number of truths which aroſe to his mind, one which ſhould be primitive, and involve all the reſt. But in this he undertook a taſk far too great, at leaſt for the then or the preſent ſtate of ſcience. He firſt perſuaded himſelf that there was but one primitive truth; he then concluded that truth could be no other than the certainty he had that he thought: but he was unqueſtionably miſtaken. We are as certain of our paſſions, and of our ſenſations, as of our thoughts; and from each and every conſciouſneſs we know our own exiſtence, which he propoſed as deducible from thought alone.

His firſt principle, "I THINK," although no one will conteſt its truth, had no particular relation to the phenomena of nature, more than any other ſimple truth, I feel, I ſee, I taſte. It was a truth far too general, and too remote from material phenomena, ever to lead him to a rational explanation of them. Accordingly, we find no cloſe and connected chain of reaſoning follows it, but mere aſſertion or hypotheſis.

All our knowledge, of every kind, originates in our external ſenſations: for it is this ſource which furniſhes us with the occaſions of our internal feelings or paſſions; and both of theſe, external impreſſions, and internal emotions, afford us ideas, about which our thoughts and underſtanding are employed.

H It is, therefore, from this ſource, external ſenſations, that we are ultimately to derive, alike our rational and our experimental principles.

I The material world, and the ſenſible appearances around us, are what we ſeek to explain. Where then ſhould we look for firſt principles to guide us, but in thoſe things we propoſe to develop. To begin in our own thoughts, in order to diſcover the cauſe of an external appearance, ſeems as little reaſonable, as if we ſhould conſult the cuſtoms and opinions of the Chineſe to account for a tranſaction in modern Europe.

K We have, therefore, conſidered the world as it is manifeſted to us by our various organs, and impreſſes us with the firſt rudiments of knowledge, as being the only ſource from whence we are to endeavour to obtain the firſt principles of philoſophy, both rational and experimental. And firſt we propoſe to inveſtigate the rational principles.

The principles of every thing are ſought by an analyſis, which, in the compound forms, diſcovers the ſimple and component parts. Chemiſtry analyzes compound bodies to arrive at their principles. Natural Philoſophy, in like manner, analyzes the compound appearances of motion, and reſolves them into ſimple: thus Newton's laws of motion have been formed. We muſt, if we would arrive at true rational principles, ſeek them in the ſame manner, by a reſolution of the compound in which thoſe principles are contained. L

The material world, or ſenſible appearances, contain, we ſaid, the principles of all knowledge. It is theſe, therefore, in which we are by various methods of analyſis, to ſeek the different ſorts of principles. M

The Chemiſt, by a ſeparation of diſſimilar parts, gets nearer to the primitive forms of bodies. The natural philoſopher, purſuing the ſame means with motion, approaches nearer to its original laws: theſe both proceed by experiment. We, as we ſeek not either motion or matter, but in matter and motion to find an idea yet more ſimple, and which ſhall be prior to them and involve them, muſt quit the method of experiment, and commit ourſelves to our reaſon. N

O But let none imagine we ſhall therefore proceed with the leſs certainty, or that we muſt forſake all confidence in ourſelves, as ſoon as we leave the limits of ſenſe: neither, in fact, ſhall we have occaſion to go out of the limits of ſenſe; for although we are, in this inquiry, to employ our reaſon without the aid of experiment, yet we ſhall employ it only about facts and ſenſible things; and whatever we ſhall perceive by a rational analyſis, that ſenſible impreſſions contain, as their ultimate principles, will be no leſs certain than thoſe things which experiment teaches us; ſince both alike, our thoughts, and our ſenſations, afford us certainty, and ſerve as the baſis of reaſon and knowledge.

P Facts, as perceived by the unlearned, are a kind of middle point, from which two claſſes of philoſophers proceed in contrary directions. The experimentaliſt, firſt analyzing theſe compound appearances, and diſcovering the principles or laws of motion, then proceeds to combine and to explain the ſame appearances, by his method of ſyntheſis. But he, as his cauſes or firſt principles, go no farther back than ſimple facts, is more properly to be called the natural hiſtorian of motion.

Q The other claſs of philoſophers, not merely ſeeking amongſt ſenſible appearances, what are the moſt ſimple, but, further, ſeeking in thoſe ſimple ſenſible appearances, for an idea yet more ſimple, which, not being diſcoverable by ſenſe, is yet evidently the origin and ſource of ſenſation; he is truly inveſtigating cauſes, and this is more ſtrictly to be termed philoſophy. The higher principles, found by this analyſis, will ſerve to involve and explain thoſe facts, which, to the experimentaliſt, are ſimple and primary. The firſt experimental principles, are no longer the firſt principles of philoſophy, but are deducible from prior ones, which this more ſublime analyſis has led us to diſcover. This continues the chain of human reaſon farther back into the receſſes of nature, and brings us nearer to the firſt cauſe.

Both of theſe paths of inquiry proceeding from one middle point, ſenſation, and meeting there, form a connected whole, whoſe parts mutually conſpire to its perfection, and to each others ſupport.

CHAP. I.

Analyſis of Matter in general.

A WE are to ſeek to arrive at firſt principles, which both truly exiſt, and are truly the origin of thoſe ſenſible facts philoſophy endeavours to explain.

B These principles we ſhall find, by reſolving the complex ideas of bodies and motions into their conſtituent and primitive eſſences.

C The nature of bodies, ſignifies the aggregate of all thoſe ideas with which they furniſh us, and by which they are made known to us.

D Bodies have various relations to us, each of which is the nature of the body, as relative to our nature, and the ſum of theſe relations is the whole relative nature of the body. The abſolute nature of body is not to be ſought among its ſenſible qualities, ſince all of theſe are its relations to us; and in theſe relations, it would be in vain to expect to find that which is not relative, but abſolute.

We

E We become acquainted with bodies through all the different mediums of our ſenſes; our ſight, our touch, our hearing, our taſte, and our ſmell. Each of theſe mediums affords us, with its own peculiarities, a great variety of ſenſations: our ſight, figures and colours; our touch, hardneſs, ſoftneſs, roughneſs, ſmoothneſs, heat, cold, moiſture, dryneſs; our hearing, all the variety of ſounds; our taſte, of flavours; and our ſmell, of odours.

F All the ideas with which any one body furniſhes us, make up the whole nature of that body; and all the ideas which we get from all the varieties of bodies, make up the ſum of our knowledge of the nature of all bodies.

G Every body furniſhes us with a number of ideas: as, for example, figure, ſize, weight, hardneſs, or ſoftneſs, colour, taſte, motion, or reſt, and others, may all preſent themſelves in one body.

H Although theſe are linked together in the object, they are diſtinct in the mind, and can each be conſidered apart from any other.

I The whole compound, in which theſe ideas are united, we call the body; each of theſe ideas, conſidered apart from the reſt, we call a quality of the body.

K Among thoſe qualities ſome are particular, ſome more general, ſome univerſal. To attract iron is the quality only of the loadſtone or magnet; to ſerve for reſpiration only of air; to afford nutriment, of moſt animal and many vegetable ſubſtances; to be extended, figured, ſolid, and moveable, of all bodies.

L The qualities of bodies are diſtinguiſhed into two claſſes: of one it is ſaid the ideas in our minds, which we call qualities, have their ſimilar archetypes in the bodies, and theſe are called primary qualities. Extenſion, figure, ſolidity, inactivity, and mobility, are called primary qualities, being ſuppoſed to be truly in bodies, juſt as they are repreſented in the mind.

M The other ſort of qualities are conſidered as not being in the bodies, but as being only the ſenſations produced in us by the action of the primary qualities on our ſenſes; ſuch are heat, cold, taſte, colour, hardneſs, ſound, and odour.

N In analyzing body we may, therefore, paſs over thoſe qualities which have no exiſtence but in our minds; ſince we cannot find in bodies

B L

colour, nor ſweetneſs, nor pain, nor ſound, theſe will have no place in our analyſis, not being preſent in the thing we analyze, nor making any part of it.

There is, however, in the bodies which furniſh us with the ideas of the qualities called ſecondary, ſomething whereby they are able to produce thoſe ideas in us; for though the ideas are only within us, they do not ariſe in us of themſelves, but have an origin in the bodies. O

We do not know what it is in the bodies which is able to produce in us ideas unlike to itſelf; but we expreſs the faculty of doing this by the term power, and ſay bodies have a power producing in us ideas of ſweetneſs, yellowneſs, heat, &c.[a] P

Hence in the body itſelf, we are, in the place of the names of all the ſecondary qualities, whoſe ideas are in our minds, to ſubſtitute one idea of power, and to conceive that the power to produce thoſe changes in us is in the body. Q

Body, then, may be ſaid to contain, or conſiſt of, all its primary qualities, extenſion, ſolidity, R figure, inactivity, and mobility, together with a power to produce certain effects on our bodies; to which we may add a power to produce, alſo, certain effects on other bodies, as the power of aqua regia to diſſolve gold, and fire to melt wax.

---

[a] Mr. Locke refers ſecondary qualities to powers in the bodies.

S This diviſion of bodies into ſeveral component parts of one united whole, is itſelf an analyſis already made; and the enumeration of the primary qualities of body, together with the power to produce the ſecondary ones, may be called the ſimple parts, which ariſe from the mental decompoſition of the compound idea of body.

T But it may be inquired, if this analyſis which others have made, be both juſt and perfect; or if, being imperfect, it may be improved and carried to a greater extent.

U Let us conſider firſt the primary qualities of bodies, extenſion, figure, ſolidity, inactivity, and mobility, and ſee if we can reduce them to any more ſimple parts.

X Extension ſeems to be a ſimple idea formed only of parts like itſelf; every extended being or ſpace is compoſed of leſs extenſions, ad infinitum, ſince no bounds can be ſet to diviſibility.

Figure is merely the limit of a finite ex- Y
tenſion. Extenſion may be carried on all ſides equally diſtant from a centre, making a ſphere; or ſome parts may be more extended than others, making any angular figure: figure is nothing in the nature of bodies, but a mere conſequence of extenſion: theſe two, therefore, extenſion and figure, afford little matter for analyſis.

Solidity is the quality of body which princi- Z
pally requires our notice; it is that which fills extenſion, and which reſiſts other ſolids occupying the place it occupies, thus making extenſion and figure ſomething real, and different from mere ſpace or vacuity. If the ſecondary qualities of bodies, or their powers variouſly to affect our ſenſes depend on their primary qualities, it is chiefly on this of ſolidity; for without hardneſs and reſiſtence, ſize and figure would do nothing towards making any impreſſion, or producing any effect. Solidity is therefore the moſt important of the primary qualities, and in it the eſſence of body is by ſome conceived to conſiſt.

This idea of ſolidity has been judged to be A
incapable of any analyſis, and not to admit of being carried beyond the intelligence which we receive of it from our ſenſes. Notwithſtanding

ſtanding this, it appears evident to me, that the idea of ſolidity may be reſolved into another idea, which is that of power, and that ſolidity depends as much on power as do the ſecondar qualities.

B We can only conceive of ſolidity as being a reſiſtence of the parts of any body, to a power which endeavours to ſeparate them, or to bring them nearer together. Now that which reſiſts any power, and prevents its effect, is alſo a power: by reſiſtence I mean here an active reſiſtence, ſuch as an animal can employ againſt an animal. If a horſe pulls againſt a load he draws it along, but if he pulls againſt another horſe he is put to a ſtand, and his endeavour is defeated. When any endeavour to change the ſituation of the parts of any ſolid is in like manner prevented from taking effect, and the parts retain their ſituation, the ſituation has plainly been preſerved by an active reſiſtence or power, equivalent to that which was fruitleſsly exerted on them.

C Since then the ſolidity of body does neceſſarily imply an active power of reſiſting within the extenſion of the body, it becomes unneceſſary, and even inadmiſſible, to ſuppoſe that the ſolidity in the body, is at all a pattern or archetype of our ſenſation.

Philoſophers do not allow colours, taſtes, or D ſounds, to be in the bodies, becauſe theſe ideas are plainly produced in us by the mediation of our organs. There appears to me an incongruity in ſuppoſing ſolidity is any more in bodies than colours and flavours are, ſince it is equally with them a ſenſation, and an idea to which the mediation of our organs is neceſſary. Mr. Locke ſays, " If any one aſks me what this ſolidity is, I ſend him to his ſenſes to inform him." The ſolidity then is in our ſenſes, not in the body. If any one aſks what a blue colour, or a ſhrill ſound is, he will alſo be ſent to his ſenſes for information; each is an idea of ſenſe exiſting only in it: and it appears to me as little juſtifiable to ſay ſolidity is in a body, as to ſay heat is in the fire; and this latter Mr. Locke thinks as improper, as to ſay, pain is in the knife that cuts a perſon.

If it is ſaid, it is not the ſenſation of ſolidity E which is in the bodies, but a real ſolidity, of which the ſenſation is the pattern; I reply, if the ſolidity in the body be a perfect pattern of the ſenſation, it is a ſenſation; but this cannot be admitted: if it be any thing different from the ſenſation, what is that difference? This we cannot learn from our ſenſes.

F Solidity as it really is (or is ſaid to be) in bodies, is confeſſed to be utterly incomprehenſible. The ſame author ſays, ſpeaking of the parts of water cohering into ice, "He that could find the bonds that tie theſe heaps of looſe little bodies together ſo firmly; he that could make known the cement that makes them ſtick ſo faſt one to another, would diſcover a great, and yet unknown ſecret; and yet, after that was done, he would be far enough from making the extenſion of body which is the coheſion of its ſolid parts, intelligible, till he could ſhew wherein conſiſted the union, or conſolidation of the parts of thoſe bonds, or of that cement, or of the leaſt particle of matter that exiſts; whereby it appears, that this primary and ſuppoſed obvious quality of body will be found, when examined, to be as incomprehenſible as any thing belonging to our minds, and a ſolid extended ſubſtance as hard to be conceived as a thinking immaterial one."

G If ſolidity as a quality in bodies is incomprehenſible, it is to little purpoſe to inſiſt on its actual preſence; and if we can conceive of matter as well without this myſterious quality, it cannot be deſirable to retain it. As a ſenſation in ourſelves, we can perfectly comprehend ſolidity; in body it is altogether unneceſſary; for a power of active reſiſtence only is required to the making impreſſions on our ſenſes, and to all the qualities which body poſſeſſes.

Solidity, confeſſed to be itſelf incomprehenſible, cannot ſerve to render body more intelligible; on the contrary, it muſt neceſſarily carry along with it its own obſcurity, and perhaps, it will be found, that to it alone is owing all the difficulty men have experienced in developing the eſſence of matter. H

Since then, ſolidity, as a ſenſation, can exiſt only in our feelings and ideas, and as a cauſe of the ſenſation exiſting in body can only be conceived to be an action, all our endeavours to form any other idea of it, being ineffectual, we ought to conſider this quality as an effect only, and not to imagine that any reſemblance of the ſenſation exiſts in bodies, nor that bodies are in any other ſenſe ſolid, than as having a power to reſiſt, from which power our ſenſations of ſolidity and hardneſs ariſes. I

INACTIVITY is the next primary quality we are to examine. Our having referred ſolidity to K an action in bodies, thereby leading to the concluſion that matter is eſſentially active, may ſeem incompatible with the idea of its being inert.

L But the activity of matter whereby it reſiſts and gives us the idea of ſolidity, is to be conſidered in a certain limited ſenſe, and its inertneſs, of which we now ſpeak, is to be regarded in another limited ſenſe, and both of theſe are compatible within their reſpective limits.

M The activity of body may be conſidered as belonging to the parts of a compound; its inertia, as the inertia of the unit formed of thoſe parts.: the actions of the parts are every where oppoſed to each other, and equal; from hence reſults the inactivity of the whole: this will be explained more at large in the ſequel.

N The inactivity of matter is a privation, and affords no ſubject for analyſis.

O We uſe the term inactivity in its ſimple and vulgar ſenſe, and not as it is uſed in the Newtonian philoſophy; it is there confounded with action, and the diſtinction between activity and inactivity is deſtroyed, becauſe inactivity is made common and indifferent to motion and reſt. Now if motion be derived from inactivity, what teſt have we of action, or how can we define the term? It is ſuppoſed that the continuance of a body in an uniform rectilinear motion is no change, and ought, therefore, to be a conſequence of inactivity; but this ſuppoſition is erroneous, and the concluſion from it is repugnant to the nature of things ([b]).

P Mobility is the laſt of the primary qualities commonly aſcribed to body; this is only a capacity of receiving motion, and no poſitive idea, and therefore affords no materials for analyſis.

Q Thus we have conſidered diſtinctly all the ideas which we derive from body, as they are commonly enumerated and claſſed; and in analyzing all the ideas we have of body we have analyzed body itſelf, ſo far as it is known to us.

R Of its primary qualities, EXTENSION, is not peculiar to body, but belongs equally to the idea of ſpace: extenſion therefore, conſtitutes nothing of the nature of body; FIGURE is a conſequence of finite extenſion; INACTIVITY is only a privation of a motive tendency; MOBILITY is a capacity of receiving motion; and none of theſe can be rendered more clear or ſimple by analyſis.

---

[b] See Examination of Third and Fourth Definitions.

S SOLIDITY, alone, of the primary qualities, is poſitive and peculiar to body, and this, on being analyzed, reſolves itſelf into ACTION OR POWER: all the ſecondary qualities are generally admitted to be powers.

T Thus all which is real, poſitive, and peculiar to body, are certain active powers, which variouſly affect our different organs, and produce in us all the ideas of ſenſe.

U The eſſence of body is then, by our analyſis, reduced to power: what can we yet further ſay of the idea of power? If ſolidity is found not to be in bodies, but to be an idea produced in us by a power in bodies, is the power then really in the body, is it without us, and independent on our ſenſations?

X The idea of power is not acquired by our ſenſes, and is not a ſenſation as ſolidity is. We deny ſolidity to be in bodies, becauſe it is a ſenſation; bodies have not the ſenſation, and the term ſolidity, if not applied to the ſenſation, has no meaning but what is more clearly expreſſed by power; therefore we ſubſtitute power for it, as it is referred to actual exiſtence in the bodies.

Y Power is an idea of reflection, it is ſuggeſted to us by thought; now if we know any thing of real exiſtence in body, our ſenſations, derived from body, not being that real exiſtence, but effects thereof; it follows that our knowledge of the real exiſtence in body muſt be ſuch as is ſuggeſted to us by our thoughts, exerciſed about our ſenſations.

Z Our own being furniſhes us with the original idea of power. We are capable of acting and producing changes in appearances, and this faculty which we experience to exiſt, we call power. We do not indeed know what is the eſſence or origin of the power, nor how it effects the change; our idea of it is therefore imperfect; it is that which can produce a change or can act. This is its characteriſtic, by which it is diſtinguiſhed from all other exiſtences which are incapable to act, or produce change.

A We are conſcious of the exertion of our own power; when, therefore, we ſee ACTION OR CHANGE happen without any exertion of power on our part, we refer this to other powers, without us, and neceſſarily conclude the POWER to exiſt where the CHANGE begins, or the ACTION is exerted.

B This power, then, referred to bodies, muſt exiſt in them, or it can exiſt no where. It does not exiſt in our minds; in our minds it is only an idea of a reſemblance to the power we are conſcious of in ourſelves, aſſociated with thoſe external appearances where we experience changes and actions. The idea in our minds is, therefore, a fallacy if the thing does not exiſt without the mind. From hence we conclude that power truly exiſts in bodies.

CHAP. II.

Analyſis of Atoms, or Primary Parts.

ALL bodies, of a ſenſible magnitude, are ſuppoſed to be porous, or to have ſpaces interſecting their internal continuity, either void, or filled with a leſs reſiſting ſubſtance. A

Theſe pores, which form, within a maſs, a number of diſtinct ſurfaces, lead naturally to an ideal diviſion of it, by an entire ſeparation of the parts, which the pores, in ſome meaſure, detach from each other. B

It is eaſy to conceive that the parts, which, by their aſſemblage, and by touching only in ſome points, form ſenſible and porous maſſes, may be themſelves porous, or made up, each, of ſmaller parts which touch only in certain points, and which lead in like manner to a diviſion of them; theſe pores will be pores of a ſecond order, and the parts, parts of a ſecond order: the ſame idea may be continued through any ſeries of orders of pores and parts. C

But

D But ſuch a ſeries muſt ultimately terminate in parts which are not porous, otherwiſe the body would be all pore, which is impoſſible.

E These ultimate parts, void of pore, we muſt conſider as containing the eſſence of a body, becauſe all that part of the ſenſible magnitude which conſiſts of interſtices between the ſolid parts, is not body.

F In any hard or reſiſting ſenſible maſs, formed of an aggregate of theſe ultimate parts, any how put together, and arranged into any number of different orders of pores and porous parts, two things are to be conſidered as neceſſary to the hardneſs or reſiſtence of the ſenſible maſs.

G Firſt. Hardneſs or reſiſtence in every ultimate part itſelf; for if each were not hard in itſelf, their aſſemblage could not conſtitute a hard maſs.

H Secondly. Where theſe hard parts touch, they muſt not only touch, but preſs together, ſo as to reſiſt ſeparation; for without this there could be no union among them, nor would their aſſemblage form a whole or united body.

This preſſure together of the parts of bodies is called coheſion. I

It is common to conceive of coheſion as a power which ſerves to cement together the ſolid parts of bodies, operating at the ſurfaces of the ſolid parts, and not to conſider it as belonging to each ſolid part ſeparately, exiſting within it, and cementing together its own parts. K

But diviſibility does not terminate where poroſity ends; the ſolid parts, which are, in regard to the orders of pores, ultimate parts, are yet extended maſſes: they have magnitude, and thoſe magnitudes have their parts diviſible, ad infinitum. L

If a ſolid part, void of pore, is an united whole, it is becauſe its two halves are attached together by a power which prevents their ſeparation, and becauſe each half has its halves, in like manner, cemented. M

The attachment of any two parts of a ſingle corpuſcle is of the ſame nature, and can be conceived of no otherwiſe, than as the attachment between any two or more corpuſcles which form a ſenſible maſs. N

O For any two corpuſcles, when cohering, form a ſingle maſs, of which each corpuſcle may be conceived a half; the coheſion of theſe can only be conceived of as a power, holding them together by the touching ſurfaces.

P Every corpuſcle has its two halves, or may be conceived as divided into any two portions, whoſe ſurfaces coincide, in like manner as the coincident ſurfaces of two corpuſcles which form a ſingle maſs; and theſe ſurfaces of the two portions of a ſingle corpuſcle, are held together by ſome power which reſiſts their ſeparation.

Q And the power in the caſe of the two parts of one corpuſcle, or of two corpuſcles, can be no ways different; power being always one ſimple idea, like to itſelf: two corpuſcles form one maſs, juſt as the two halves of a corpuſcle form one corpuſcle.

R We may conceive the power to exiſt in different degrees. We may conceive two parts of the ſame corpuſcle, held together more ſtrongly than two corpuſcles; and that any two corpuſcles would ſeparate with a leſs force than would be required to break either of them; but theſe are different degrees of the ſame thing.

We are not, then, to conceive of coheſion as a power exiſting only without the primary corpuſcles, and operating only at their ſurfaces to attach them to each other, but alſo as a power whereby the parts of each corpuſcle are held together, and by which the corpuſcle exiſts, a ſolid and extended maſs. S

Nor can theſe primary atoms conſiſtently be denied to have parts, or be diviſible; although they may have no diviſion by pores, nor are ever in the order of nature broken down into ſmaller parts, and are thus, in reſpect to the actual courſe of events, primary and indiviſible atoms, yet every atom has magnitude, and conſequently parts, which, though never ſeparated from each other, exiſt diſtinct in the whole. T

But as theſe parts are diſtinct, they are ſeparable, and are held together by ſome bond of union or coheſive power. U

Every part of a primary corpuſcle may be conſidered as attached or cohering by its ſurface to a contiguous part of the ſame corpuſcle. X

Theſe contiguous and cohering ſurfaces may be aſſumed every where within the corpuſcle. Y z At every ſurface nothing is found but an attaching or cohering power; for the ſurfaces themſelves are not parts of the corpuſcle, but terminations of the diſtinct parts.

A Therefore, on purſuing a diviſion of the corpuſcle indefinitely, power is the idea which continually occurs, and the reſolution of the idea of the corpuſcle continually into ſmaller parts, preſents to us continually the powers which mutually attach thoſe parts; nor can any other idea be found.

B If it be ſaid, that by thus dividing a corpuſcle in idea, we get a continued diviſion of *ſolid parts*, held together by *power*, and ſo preſerve the idea of ſolid parts cohering, I aſk, what is this idea of ſolid parts, which we have diſtinct from the powers by which they cohere; what is there in the ſolid maſs, beſides the power which makes it hard or ſolid?

C This we cannot learn; we have no idea of hardneſs or ſolidity but by our ſenſes, and theſe ſenſations are not in the body, but are produced in us by powers within it.

D Thus, nothing is found by analyzing a ſolid corpuſcle, but power or action: power, therefore, conſtitutes ſolidity, and is its eſſence.

E The reſiſtence or ſolidity of an atom, or of any maſs, is twofold; it is a reſiſtence to a nearer approach, and to a more diſtant receſs. The parts of a hard maſs reſiſt being preſſed together, or being pulled aſunder.

F This affords us only a two-fold modification, or application of the ſame idea.

G Both theſe modifications of power are neceſſary to the exiſtence of ſolidity, or a finite reſiſting extenſion, becauſe either exiſting alone would be ſelf-deſtroyed.

H If in any active extenſion there exiſted *only* a power which directed all the parts within itſelf, the parts of the active extenſion would be carried inwards till the extenſion was loſt.

I If there were *only* a power which directed all the parts outwards, urging them to ſeparate, the extenſion would ſpread, and the action loſe itſelf in infinity.

K Therefore the idea of a finite active extenſion, that is of any ſolid maſs, implies the two powers,

ers, a power directing the parts inward or nearer together, and a power directing the ſame parts outwards, or further aſunder, and theſe two powers equilibrating with each other, that neither prevails.

L Thus, whether we analyze body by its ſenſible qualities, or by its component parts, we come at the ſame original principle, which is eſſential to it in every form, and preſents itſelf at every view.

CHAP.

CHAP. III.

Error of the Doctrine of Impenetrability.

IMPENETRABILITY is that quality, aſcribed to matter, whereby every ſolid part excludes every other from within its own limits. This implies, that no ſolid part can be condenſed into a leſs ſpace than it occupies, nor extended ſo as to fill a greater, but that all have an equal and a neceſſary denſity, or equal quantities of matter within equal magnitudes; for if a body, from any ſize, can be rarefied into a greater, it can be re-condenſed into its former bulk, and this condenſation would be a penetration of its parts. A

Solid parts being ſuppoſed impenetrable, the actual penetration of ſenſible bodies was attributed to the admiſſion of the penetrating ſubſtance into the pores with which matter abounds. B

This doctrine affects the fundamentals of physics, and it is, therefore, of great importance C to have its truth or error unequivocally aſcertained.

D Immaterial ſubſtances, it was allowed, could pervade bodies; but theſe were ſuppoſed incapable of acting on them by penetration or impulſe, and to have influence only by volition. Material ſubſtances penetrating the interſtices only, could not act but on the ſurfaces of the ſolid parts, and conſequently their action could be ſuppoſed proportional to thoſe ſurfaces only, and not to the maſs.

E But as the forces of moving bodies are proportional to their maſſes, the theory of any penetrating agent acting mechanically was precluded, becauſe ſuch could not penetrate the ſolid parts, by reaſon of their impermeability, nor, acting on their ſurfaces, could operate proportionally to the ſolid maſs.

F There are now, among thoſe who in the main profeſs the Newtonian philoſophy, ſome ſceptics to this opinion, held eſſential in the earlier times of that ſyſtem, and at preſent by its more rigid adherents.

G This defection does not ſeem to have ariſen from a deſire to eſtabliſh the theory of a permeation of a moving cauſe, againſt which impenetrability was ſet up; but rather from a ſecurity in the preſent doctrine of ACTION ON THE SURFACES, and of VIS INERTIÆ, imagining theſe to be now in themſelves ſufficiently firm, impenetrability, their original ſupport, is deſerted, as having become unneceſſary, and as being little defenſible. Theſe incautious architects truſting to the ſtability the building has ſeemed to have acquired, from time and collateral props, allow the baſis to be removed, without being aware that they expoſe the whole fabric to ruin; for when this barrier to a theory of permeation ſhall be done away, THAT will be found to have ſo many advantages over the notion of action at the ſurfaces, as will give it an indiſputable claim to preference.

So little has been ſaid in defence of the H
doctrine of impenetrability, and ſo ſmall are its pretenſions to proof, that not many arguments can be required to invalidate its force.

In order to examine, and combat the idea of I
impenetrability, we need not inſiſt upon power being the eſſence of body. If we merely conſider matter as ſomething that fills ſpace, and by filling a ſpace excludes other matter from the

ſame, this, without taking action into conſideration, does not imply impenetrability.

K The terms impenetrability and ſolidity have, indeed, by ſome, been uſed as nearly ſynonimous; or at leaſt it has been conſidered that impenetrability was a conſequence of ſolidity, and was implied in it; but this we ſhall ſhow to be unfounded.

L Fulneſs is an idea capable of intention and remiſſion; the ſame extenſion may be filled with different quantities of the filling ſubſtance; it may be more or leſs full, in all poſſible degrees.

M Our ideas of the differences of denſities in bodies, is that of different fulneſſes. Denſity is indeed, by philoſophers, defined to be the number of ſolid parts within a given magnitude, each ſolid part being ſuppoſed equally denſe, and the differences in the degrees of denſity in the body to depend on the different quantity of pore.

N But aſſuming the equal denſity of ſolid parts, is begging the queſtion for impenetrability: to prove the impenetrability of matter, it muſt be *proved* that ſolid parts are of neceſſity equally denſe, that is, contain the ſame reſiſtence within the ſame extenſion.

For if any two ſolid, imporous parts, of a given magnitude, can have different quantities of matter, whatever matter be, whether an inactive or an active repletion, then the given magnitude being filled with the leſs quantity, as in the part which contains leſs matter, can yet admit more or be more full, as in the part containing more matter; but more filling ſubſtance being admitted into an extenſion already full, is a penetration of that which at firſt filled the extenſion. O

Now to determine this queſtion, we may place it in two lights, each of which appears to me deciſive. P

Firſt, whether we can diſcover any natural or neceſſary relation which a given quantity of ſolid imporous matter has to a given magnitude. If a magnitude be given, what is the quantity of matter neceſſary, without pore, to fill it, and why is that quantity alone capable of being contained in, and filling that magnitude. Q

We can, I believe, aſſign no reaſon why among infinite quantities, one, more than another, ſhould be neceſſary to a given magnitude; why all poſſible quantities, may not aſſume and fill that magnitude; or why any given quantity R tity of matter may not occupy and fill infinite different magnitudes.

S It has been demonſtrated that a grain of ſand might be made to equal, in volumn, the orb of Saturn ; or any given quantity of matter aſſume any given volumn, by forming ſucceſſive ſeries of porous parts : in this caſe, the magnitude of the ſolid body would not be increaſed, but its volumn only would be enlarged by the quantity of pore which interſected the ſolid continuity.

T But if the above neceſſary limits (Q 35) cannot be aſſigned, there is no reaſon why a grain of ſand may not fill the orb of Saturn, or any greater magnitude, without any increaſe of its pores, but by the increaſed tenuity and expanſion of the ſolid matter.

U We may next inquire whether we can conceive of a difference of denſity in ſolid parts, independent on pores. Of this there can be no doubt, when we conſider that children and the vulgar have no knowledge of inſenſible pores, yet they neceſſarily conceive of ſuch bodies as gold and ſteam, as differently denſe, or conceive of varieties of quantity in theſe different bodies, under the ſame magnitude.

Since then we can conceive of no neceſſary limitation to denſity, or can diſcover nothing in nature which ſhould render it invariable; and ſince we do familiarly conceive of different denſities in bodies, the doctrine of impenetrability muſt be conſidered as hypothetical, until it receives proof either from experiments, or from rational deductions. X

Now experiments cannot poſſibly eſtabliſh this doctrine; for no difficulty, however great, experienced in penetrating bodies, can afford a concluſion, that greater forces than have yet been employed, might not overcome the reſiſtence which has only been inſuperable to an inſufficient power; and it is not the actual impenetrability to any human force, or to any force which nature employs upon matter, which is intended, but a natural and neceſſary impenetrability, in itſelf unſurmountable by any poſſible force. Becauſe water has been found to have its parts reſiſt a very ſtrong preſſure, rather than mutually penetrate each other, no concluſion follows that they are not eaſily permeable to more ſubtil matters, unleſs the impermeability be conſidered as neceſſary and abſolute. Y

As to rational proof, I have never ſeen any attempted, nor can imagine any that can with Z a ſhew of plauſibility be offered: for the rational proof muſt conſiſt in ſhewing that the penetrability of body would imply a contradiction; but the contrary of this appears, ſince we readily conceive of it as penetrable, and are unable to imagine how it can be deprived of its penetrability.

A Conceiving of matter in its other, and true light, as an active fulneſs of extenſion, or as an extenſion full of action, the ſame method of reaſoning will apply.

B As we have no neceſſary bounds to our idea of denſity, ſo have we no limits to that of action.

C Any given action, filling any extenſion, and producing reſiſtence, and our idea of ſolidity, may be conceived as liable to be ſubjected to a greater action, and its reſiſtence thus to be overcome and the ſolidity or extenſion penetrated.

D We ſaid no argument for impenetrability can be deduced from any actual reſiſtence, becauſe the action reſiſted, however great, is neceſſarily limited (Y 37).

E But it will further confirm our objection to this principle, ſo far as it is ſuppoſed to reſt on facts, to ſhow that reſiſtence does in fact take place in caſes where impenetrability, and even ſolidity, are not ſuppoſed by any.

For if in any caſes of reſiſtence, ſolidity be F
found actually wanting, it will appear in all others unneceſſary, and that which is certainly unneceſſary and not certain in fact, we ſhould conclude not to be.

The beginnings of all actions afford the facts G
to which we allude. Gravitation, muſcular action, magnetiſm, all of theſe may be conſidered as reſiſtences ſimilar to that of hardneſs in bodies.

If with my hand I ſtrongly compreſs two H
bodies together; if a heavy body be preſſed to the earth, or a piece of iron to a magnet, is not the preſſure, a hardneſs or ſolidity between the bodies, ſimilar to, although it may be leſs than that which holds together two cohering parts of the ſame body? Yet no one traces the origin of theſe preſſures to an impenetrability in muſcular action, gravity, or magnetiſm.

Let us endeavour to bring together two like I
poles of a magnet, and we ſhall experience a reſiſtence to their approximation. Does any one

ſay, the extenſion between the magnets is impenetrable, or is ſolid, or is an inactive fulneſs?

K Why may not, then, a piece of iron, which, between our fingers, reſiſts their coming together, reſiſt by a ſimilar efficacy more ſtrongly exerted, inaſmuch as the effect is greater?

L If magnetiſm were to act on our bodies, as upon iron, we ſhould feel it; or were magnets endowed with ſenſation, they would feel that which reſiſts their nearer approach.

M The reſiſting extenſion between the two magnets is permeable to all the rays of light, and reflecting none, is unſeen; but it is eaſy to conceive that the ſame power which reſiſts the approach of the iron, might reſiſt and reflect ſome rays of light. We ſhould then have a viſible object interpoſed between the two magnets, or extending round every magnet to the limits of its repelling ſphere, as we have before ſuppoſed it might be a tangible one.

N That which is tangible can be conceived as applied to our organs of taſting, of ſmelling, and of hearing, and as capable of exciting ideas of flavours, odours, and ſounds.

Thus by a very eaſy tranſition, by only ſuppoſing the magnetic action to be exerted on our bodies, and upon light, inſtead of being confined to iron, we ſhould find it to poſſeſs all the characteriſtics of a ſolid body. O

But would any change in the nature of the action deſtroy the action; would the magnetic virtue become an inactive ſolid by having its effects extended to light and a human body? This is not at all implicated. P

Thus, we ſee, an action in which no ſuppoſition of ſolidity or impenetrability is involved, may be conceived to aſſume all the qualities of matter, by only ſuppoſing a familiar effect extended in its operation. Q

The author of the Preliminary Diſcourſe to the French Encyclopedia reaſons thus, in ſupport of his argument to prove that ſenſations are the principle of all knowledge: "It is ſufficient," ſays he, "to prove that they are capable of being "ſo; for our ſenſations are the moſt certain "facts, and facts, or acknowledged truths, are to "be preferred before an hypotheſis as the baſis "of any deduction." R

S This juſt and philoſophical ground of argument is applicable to our preſent queſtion.

T Having ſhewn that action is capable of producing the idea of ſolidity, and, by conſequence, all ideas dependent on it, and which are only its various modifications, this is proof ſufficient that action alone is the principle of all our ideas, and baſis of all our ſenſations; becauſe action is actually found to exiſt in all, and any other origin is hypothetical.

U The inactive ſolidity, the inert fulneſs of ſpace, the unknown ſomething, the myſterious ſubſtratum, about which philoſophers have talked, being altogether inconceivable, altogether hypothetical, and wholly unneceſſary; while action is conceivable, truly exiſting and ſufficient: if any one, without being able to prove theſe premiſes erroneous, ſhould yet inſiſt on the ſolidity and impenetrability of matter in the ſenſe here contended againſt, he muſt form his concluſion on grounds ſo different from thoſe which direct my judgment, that it would be fruitleſs for me and ſuch a perſon to debate the queſtion.

X And he who denies a ſtate of action in every thing we call ſolid extenſion, and chooſes to inſiſt on matter being an inactive fulneſs; or admitting the ſtate of action, yet maintains the exiſtence of a ſolidity, which is inactive, and can ſupport theſe opinions by any reaſoning becoming a philoſopher, would open a door of knowledge of which I have, at preſent, no conception, and I ſhould be glad to receive inſtruction from him.

The doctrines of the IMPENETRABILITY of body, and of its INACTIVITY, ſerve mutually to ſuſtain each other, and it is difficult to determine which is prior, which ſubſequent. The notion of each primary atom being in itſelf inactive and cohering to others, ſo as to form larger bodies, by actions exerted at the ſurfaces only of the primary atoms, renders it neceſſary that thoſe primary parts ſhould not be liable to decompoſition, there being no action *within* them, by which any two parts could reunite, like that *without*, by which two parts coaleſce. y

This opinion of inactivity within the primary corpuſcles, gave riſe to a fear, that if they ſhould be broken by any violence in the order of nature, or changed in wear, by having parts rubbed off into finer ſubſtances, and thus the original figure and ſize be deſtroyed, they could no longer ſerve to form the ſame kind of bodies which they did in their priſtine ſtate; that, for example, water formed of old and damaged atoms, would be z unlike the water at firſt produced by the new and perfect parts.

A But this apprehenſion is founded upon the very extraordinary ſuppoſition, that although an action exiſts between the ſurfaces of the original corpuſcles, cementing them ſtrongly together, nevertheleſs, between any two parts of each original corpuſcle, which are yet more ſtrongly attached, there is no action at all.

B But as we have ſhewn, and the thing is indeed evident, that action is no leſs eſſential to the exiſtence of the primary parts than to their union, we need no longer be ſolicitous to prevent their penetration or diviſion, ſince the ſame action, within, can preſerve the atom, although penetrated, from being deſtroyed, as without, can maintain or reſtore their coaleſcence which conſtitutes the forms of ſenſible bodies.

CHAP.

CHAP. IV.

Analyſis of Motion.

SINCE all natural appearances conſiſt either of matter or motion, when, by a juſt analyſis, we ſhall have arrived at the ſimple and conſtituent parts of theſe, we ſhall have got to the baſis of the fabric of the material world, to the foundation ſtone of the building, beyond which, if we advance, we ſhall paſs the line that ſeparates unconſcious from conſcious being, and find ourſelves without the boundaries of corporeal nature. A

To analyze motion is an attempt not very conſonant to the prejudices of the preſent times, which conſider it as a ſimple idea, therefore undiſtinguiſhable into parts, and undefinable; but that this is erroneous, will, I think, eaſily be made appear. B

We cannot conceive of any actual motion without combining together theſe three ideas, a BEING which moves, a PLACE in which that being is, and the CHANGE of that place: hence the definition given. *(See Defin.)* C

Let

D Let us conſider each of theſe three conſtituent parts, and ſee what each is in itſelf, whether each is not diſtinct from the other two, and whether all of them are not neceſſary to the idea of motion.

E Firſt. A BEING which moves. A being may be conſidered without motion: ſuch is matter at reſt.

F Secondly. A PLACE. Place is that relation of one being to another, which conſiſts of *diſtance* and *direction*. From a given body a mile north, in one place, two miles north, a ſecond, a mile ſouth, a third, two miles ſouth, a fourth. Every variation of diſtance or direction, produces a variation of place. *Diſtance* and *direction* appear to me to be ſimple ideas, and incapable of definition.

G Thirdly. CHANGE. Change in any being is a ceſſation of ſome circumſtance which was, and the production of one which was not. If a cubic figure be moulded into a ſphere, the cube which was, has ceaſed, the ſphere which was not, is produced.

H It is ſaid by ſome, that change implies motion, and therefore cannot be a part of its definition, being the very thing defined: to this I anſwer, we are ſpeaking of the ſenſible idea of motion, as it appears to our ſight; now changes do appear to our view, and to all our ſenſes, which give us no idea of motion. Changes in heat or coldneſs; in colour, flavor, ſmell, ſound, hardneſs, ſoftneſs, pain, pleaſure; in theſe, and many other ideas, changes do not produce ideas like that produced by a ball rolling, or a ſtone falling. We may perhaps ultimately trace them to motion, but to inſenſible motions; to motions which ariſe only in reflection, and conſtitute no part of the actual idea of the change.

We can, therefore, conceive of change without conceiving at the ſame time of motion. They are diſtinct, as ſenſible impreſſions, however they may be derived from one cauſe and have one eſſence. I

Change is a generic idea, including many ſpecies; motion, as a ſenſible idea, is a ſpecies of that genus. Motion is one ſpecies of change, but there are alſo many others. K

Change is therefore a neceſſary part of the definition of motion; it marks the genus of the thing defined. Motion is a change; but as there are many ſpecies of change, which of thoſe ſpecies L cies is motion? The anſwer is, it is a change of place. This marks the ſpecies, and diſtinguiſhes it from change of colour, of temperament, of figure.

M All of theſe ideas (c 45) are diſtinct from each other. The body is diſtinct from the poſſible places it may ſucceſſively occupy; the places a body may be conceived in ſucceſſion to occupy, are diſtinct from the actual ſucceſſive preſence of the body in thoſe places.

N All of thoſe ideas (c 45) are eſſential to motion; otherwiſe which can you leave out of the idea without deſtroying it?

O The combination of theſe conſtitutes motion; otherwiſe what is that which is further neceſſary? Theſe three, therefore, are the principles of motion reſulting from its reſolution.

P Since, therefore, change is an eſſentially conſtituent part of motion, and by the definition change implies action, it follows THAT ALL MOTION IMPLIES ACTION, AND DEPENDS ON AN ACTIVE CAUSE.

Q Thus far we have conſidered motion as a whole; we will next regard it in its parts. Every motion has a beginning, a middle, and an end. The beginning is a change from reſt to motion; the middle is a continuance in motion; the end is a change from motion to reſt. I am to ſhew that the beginning of motion is by an action began; the continuance of motion by an action continued; the end of motion by a ceſſation of the action.

R The firſt poſition is admitted by every body.

S That the CONTINUANCE of motion is by an action continued, will be proved if it ſhall be ſhewn that the continuance of a motion is nothing different from its beginning, in regard to any point of time aſſumed in the continued motion.

T In what then it is aſked does the beginning of motion conſiſt? In a change from reſt to motion? This is no definition, becauſe it defines motion by motion; the beginning of motion does not conſiſt in the reſt which preceded it; therefore this definition amounts only to ſaying the beginning of motion conſiſts in the beginning of motion.

U I ſay then the beginning of motion conſiſts in the beginning of change of place.

x Now if any given portions of time and of ſpace are aſſumed, a body beginning to move in the commencement of that time and in the firſt portion of the ſpace aſſumed, then and there begins that particular motion, and whether before the body began to move in that ſpace, it was moving in other ſpaces and times, has no relation to the motion in queſtion; for this being in a time and ſpace altogether diſtinct, is a diſtinct motion from any which might have preceded it immediately, as much as from a motion which preceded it a thouſand years before. It is therefore a new motion began; and ſo it may be ſaid of every aſſumable point in the continued motion.

Y The term continued ſerves only to connect any two diſtinct motions, the end of one with the beginning of the other, but does not deſtroy their diſtinctneſs.

Z It is alleged on the contrary ſide, *that a body in motion requires an active force to ſtop it, but by reaſon of its own inactivity not being able to exert any active force to ſtop itſelf, it muſt neceſſarily continue in motion as a conſequence of that inactivity, till ſome other force ſtops it.* This is I believe a fair ſtatement of the argument uſed to prove that INERTIA and not ACTION is the cauſe of continuance in motion; and in this way I have heard ſeveral eminent mathematicians argue, who confeſſed the *term* vis inertiæ was indefenſible, retaining however all the incongruity in the *idea*.

If we only put together the premiſes and conclusion in this argument, who can believe one to A
reſult from the other? The premiſes ſtate, that an active force is required to ſtop a moving body, and the concluſion is, that therefore a moving body is without any active force, and moves by its inactivity. Is it analagous to our reaſoning in common affairs, to infer inactivity in the doing of that which it requires action to reſtrain?

But we will examine the chain that leads to B
this concluſion, and point out where is its fallacy; and for greater preciſion we will put the argument in the ſyllogiſtic form.

I.

Every body in motion requires an active force C
to ſtop it.

No body in motion has any active force in itſelf.

Therefore, no body in motion can ſtop itſelf.

II.

D A body in motion is unable to ſtop itſelf, by reaſon of its want of an active force.

But a body in motion of itſelf continues to move by reaſon of its inability to ſtop itſelf.

Therefore, a body in motion continues to move by reaſon of its want of an active force, or by its inactivity.

E The argument thus laid out, diſtinctly, in its parts, ſhews plainly where its error lies. The minor, or ſecond propoſition in the firſt ſyllogiſm, is directly an aſſumption of the thing in debate, a *petitio principii.*

F It aſſumes that A BODY IN MOTION IS INACTIVE, and thence it is proved, firſt, that it cannot ſtop itſelf, then that it continues to move as a conſequence of its inactivity; but that A BODY IN MOTION IS INACTIVE is the very thing in queſtion, and denied by the antagoniſt in the debate; THAT, therefore, is to be proved by ſome prior reaſoning, and not to be aſſumed in order to prove itſelf.

G Further, this ſecond propoſition is not only a *petitio principii*, but it appears no leſs evidently to be contradictory to the major, or firſt propoſition. That a body in motion requires an active force to ſtop it, is the ſame thing with ſaying a body in motion has an active force in itſelf; it being plain, that whatever produces an effect, and requires an active force to deſtroy that effect, muſt be itſelf an active force; for the active force employed to *ſtop* a motion, would, in other circumſtances, *produce* a motion. Where then, it does not *produce* but only *ſtop* a motion, itſelf has deſtroyed the productive agency in the motion which it puts an end to, and its *own* producing power has been deſtroyed by the agency *it* deſtroys. This reſults from the truth evident in reaſon and in fact, that equal contraries, meeting, deſtroy each other.

The third propoſition or concluſion of the firſt ſyllogiſm is mere trifling, or ſomething worſe. It ſtates that a body in motion *cannot* ſtop itſelf; it having been before *ſhewn* that it requires an active force to ſtop it, and *aſſerted* that itſelf poſſeſſed none, it to be ſure follows that it cannot ſtop itſelf. But it has been ſhewn that a body requiring an active force to ſtop it, is an evidence that itſelf does poſſeſs an active force, and that if it cannot ſtop itſelf, it is not by reaſon of its want of a force to oppoſe to its own motion, but by reaſon of the force it poſſeſſes diſpoſing it to move. Nothing can be more repugnant to reaſon and experience, than, in a moving body, to look for ſome power oppoſed to the motion it is found to have, and finding in it nothing oppoſed to its own motion, to aſcribe its continued motion to the privation of any force which might oppoſe it, rather than to the preſence of a force which preſerves the motion. Do we aſcribe a man's actions to the privation of a volition which might oppoſe them, or rather to the preſence of a volition which directs them? Thus contrary is it to every other principle of reaſoning, and to the plaineſt evidence, to aſſert a privation of force in a moving body which is capable of exerting force in every part of its continuity. This concluſion is trifling, inaſmuch as it aſſerts *that a body in motion cannot ſtop itſelf*, becauſe it is not *diſpoſed* to do ſo, and it is erroneous, ſo far as it implies another cauſe, to wit, the want of an active force.

i The ſecond ſyllogiſm, which is built upon the firſt, muſt evidently fall with it.

k The argument by which from the ſame premiſes (*i. e.* that a body in motion requires an active force to ſtop it) I draw a contrary concluſion, I ſhall next ſtate in a ſimilar manner, and ſubject every part to the ſame critical review which has been taken of the other.

I.

Whatever requires an active force to ſtop its motion, is diſpoſed to move. L

Every body in motion requires an active force to ſtop its motion.

Therefore, every body in motion is diſpoſed to move.

II.

Whatever is diſpoſed to motion is poſſeſſed of action. M

But a body in motion is diſpoſed to continue in motion.

Therefore, a body in motion is poſſeſſed of action.

Thus it appears that the middle part of any motion (Q 48) is action equally with its beginning. N

The laſt part of motion is its TERMINATION. O It is admitted that all motion is terminated by an action contrary to the direction of the motion. It is admitted too that the moving body *acts* at the time its motion is deſtroyed. Thus the BEGINNING and the END of any uniform motion are confeſſed to be actions; but all the intermediate CONTINUATION which connects the beginning with the end is denied to be an action. What can be more unaccountable than that the ſame uniform motion ſhould have action at its commencement, and action at its termination, yet be inactive during the whole time and ſpace between the two extremes? How does the action at the beginning become changed into a privation of action? How does the privation ſuddenly become action at the end? Is it not more conſonant to reaſon and analogy to aſcribe to the whole continued motion, one uninterrupted action? Such a concluſion, true philoſophy, we think, requires us to make.

P When the reader conſiders that on this ſingle queſtion, *whether a continuance in an uniform motion in a right line* be the effect of INERTIA, or of ACTION, the whole of the theory of the philoſophy at preſent received depends, he will not think I have entered too much into minutia in its diſcuſſion; and when he learns that if he admits, what to me appears ſelf evident, and to ariſe from the definition of action, that motion can only be continued, and only ſubſiſt by action, he will then have it little in his power to refuſe the remaining part of the doctrine laid down in the following pages; he will not think his attention miſemployed in forming his deciſion, independent on the opinion of others, from the conviction of his own mind.

CHAP. V.

Action is an Attribute of an active Subſtance.

IN the foregoing chapters it appears that all phenomena are produced by action; we ſhall now proceed to ſhow, that where there is action, there is ſome SUBSTANCE which acts. A

Our manner of conceiving things is analagous to the general diviſion of phenomena into matter and motion. All our conceptions of being are referrible to SUBSTANCE, or ATTRIBUTE; to things which exiſt of themſelves, or things which have being only in ſome other. B

To move or act, is an attribute; that which moves or acts is the ſubſtance. C

D We cannot conceive an attribute to exiſt without a ſubſtance: for example, we cannot conceive of whiteneſs as exiſting without ſomething elſe beſides the whiteneſs, and which we ſignify by ſome ſuch mode of expreſſion, as *the thing which is white, that to which whiteneſs belongs.*

E In like manner, we cannot conceive of action as exiſting without ſomething which acts, to which action belongs, or, which has the quality of action. Action is a verb, requiring its ſubſtantive, and this neceſſity in grammar is founded on a prior neceſſity in our manner of conceiving ideas.

F We have traced all phenomena to action, as to a generic idea, comprehending under it all forms of matter and motion, as ſpecies of that genus.

G By this analyſis, that complex idea we have uſually denominated matter, and conſidered as the ſubſtance, or ſubſtratum, to which motion appertained as an attribute, has been found to change its character, and to be itſelf an attribute.

H The ACTION of a BODY IN MOTION is indeed the attribute of the body, and the body relatively to its own motion, is truly a ſubſtance, having the attribute or quality of motion ; but the body being a name ſignifying a combination of certain ideas, which ideas are found to ariſe from action (T 20), that action which is productive of thoſe ideas whoſe combination we denominate body, is of the nature of an attribute ; in other terms, body is to be conſidered as an attribute ſo long as it is conſidered as conſtituted of action.

To this attribute we muſt neceſſarily aſſign its ſubſtance. The actions which conſtitute body muſt be actions of ſomething, or there muſt be ſomething which acts. I

WHAT then is this ACTIVE SOMETHING from whoſe agency we get the idea of body, or, whoſe actions conſtitute body. K

Is it not ſufficient that it is SOMETHING ACTIVE ? When we ſay ‘ WHAT is this ſomething,’ let us aſk ourſelves what the queſtion purports. Is it to get a name ? that would be an eaſy taſk, we might give it an old name, or a new one, and define it to be ſomething which acts to conſtitute body ; but would the name render the idea more clear ? L

M Do we want a character, or deſcription of the thing? Its character is that it acts; its deſcription may be found in every ſenſation: it is colour to the eye, flavour to the palate, odour to the noſe, ſound to the ear, and feeling to the touch; for all our ſenſations are but ſo many ways in which this ACTIVE SOMETHING is manifeſted to us. No one ſenſible deſcription, therefore, can ſerve for that to which all are common.

N Do we aſk what it is in itſelf, independent on being ſeen, felt, taſted, ſmelt, or heard? I reply, I know not; having no other means of perceiving it, but one of theſe, and in each of theſe it aſſumes its peculiar deſcription.

O At preſent we ſhall call that ſubſtance of which body is an attribute, the ACTIVE SUBSTANCE.

P An INACTIVE ſubſtance, or ſubſtratum of matter, philoſophers have imagined to exiſt, but have in vain ſought to find. They ſaw the neceſſity of a ſubſtratum for the qualities of body, and having imbibed the notion of inactive matter, they ſought for it an inactive ſubſtratum. At the ſame time they were perſuaded that all the qualities of body were active POWERS they ſought an INACTIVE ſupport in which they might inhere, a POWERLESS origin from which thoſe POWERS might ariſe. Can it be wondered this reſearch was fruitleſs?

They ſought to conceive what muſt of neceſ- Q
ſity be inconceivable; a ſubſtance, devoid of attribute, a being, without a quality, of which nothing could be declared that it DOES or IS. Having ſtripped it of all conceivable conditions, they endeavoured to comprehend it. Might not the diſappointment of ſuch an attempt have been foretold? They fain, indeed, would have preſerved, at leaſt, the general idea of exiſtence; but the idea of exiſtence vaniſhed when all its qualities were gone.

Our ACTIVE SUBSTANCE is the ſubſtratum R
ſo long ſought for and with ſo little ſucceſs. We give this ſubſtance a quality by which it may be conceived. It ACTS. From this primary quality all the reſt ariſe; ALL SENSIBLE QUALITIES ARE MODES OF ACTION, and action is common to them all. This renders the view of nature clear and conſiſtent; we have no longer to ſeek exiſtence in non-entity, nor life among the dead.

One modification of ACTION produces MAT- S
TER, another generates MOTION; theſe modifications

fications of action are modes of the active ſubſtance, whoſe preſence is action: matter and motion conſtitute the whole of nature. THERE IS, THEREFORE, THROUGHOUT NATURE AN ACTIVE SUBSTANCE, THE CONSTITUENT ESSENCE OF MATTER AND IMMEDIATE NATURAL AGENT IN ALL EFFECTS.

T Other inquiries may now occur, as whether this active ſubſtance be body or mind, material or immaterial, intelligent or uninformed; how it conſtitutes matter, and how it produces motion; theſe things we ſhall inveſtigate in their places.

CHAP.

CHAP. VI.

On the Exiſtence of an external, unintelligent Agent, with a Review of ſeveral Opinions, particularly that of BERKLEY, *on the Subject.*

WE ſhall, in this chapter, inquire whether A
or not the primary ſubſtratum of matter or active ſubſtance poſſeſſes intelligence; and here it will be proper to notice what other opinions have been of late days maintained, concerning the actual external exiſtence of the world, ſo as to give a comparative view of them with that offered in this work.

One opinion, very recently contended for is, B
that material things exiſt without us, independent on being perceived, in the forms, and with the qualities which we aſcribe to them from the impreſſions they make on our ſenſes: a notion ſo unphiloſophical and oppoſed to the firſt illuminations of ſcience, which conſiſt in correcting

the errors of judgment formed upon our ſenſes alone, that it is ſufficient to mention it, without undertaking its refutation in this work.

C The doctrine maintained by Locke, is, that matter actually exiſts, ſolid, inactive, extended, figured and moveable, and theſe qualities are conſidered as primary and eſſential; but that it is in itſelf deſtitute of colour, flavour, odour, ſound, and feeling, theſe, called ſecondary qualities, being ſaid to exiſt only in our perception, and to be produced in us by the operation of the primary qualities.

D Another doctrine publiſhed at Venice in the year 1763, by M. Boſcovick, ſaid to have been firſt thought of by Mr. Mitchell, and lately defended by Dr. Prieſtley, is, that matter is penetrable, and conſiſts only of centres ſurrounded, at different diſtances, with ſpheres of attractive and repulſive powers, being unſolid and eſſentially active.

E Berkley carried his abſtraction ſtill further, and argued that there was no intermediate agency between our minds and the ſupreme mind; that the world had no real being but in the reality of our ideas, and in the perception of the ſupreme mind which communicates them to us.

Of the firſt of theſe,' which correſponds with the Newtonian philoſophy, it is not neceſſary to add any thing here, to what is contained in the preceding chapters. F

The two latter agree that nothing INERT exiſts in nature, but differ, in that one admits ſecondary active powers; while the other allows of no *mediate* inſtrument, but refers all our ideas *directly* to the volition of Deity. G

The former of theſe two anſwers in general to the opinion here maintained, and I ſhall briefly ſhow, in this chapter, where appears to me to lie the error of the reaſoning Berkley employs in defence of the latter. H

Although the theory of Boſcovick has a general agreement with the doctrine of this work, inaſmuch as it denies ſolidity, and aſſerts ſecondary powers without us, we do not accord in the manner of inferring or of treating of thoſe powers; he confines his view to powers, and, not leading our mind to any ſubſtance as their ſupport, gives us the obſcure idea of an attribute without a ſubſtance; and in uſing the terms attraction and repulſion he falls into the error of ſubſtituting the names of effects for cauſes, and explains nothing; it not being more intelli- I gible how two diſtant centres ſhould act on each other, than how two diſtant bodies ſhould do ſo.

K It remains, that I examine the grounds on which Berkley denies all exiſtence but mind, rejecting, not only ſecondary qualities with Locke, and ſolidity with Boſcovick, but alſo extenſion, figure, action, and motion, as external beings, making all of theſe, ideas only, and wholly within a perceiving mind.

L The limits peſcribed me do not allow of my quoting him at length, nor is this neceſſary, as I ſhall have to contend moſtly with his principles, and if theſe be erroneous the concluſions muſt neceſſarily fall.

M His fundamental poſition is, " THAT WE CAN PERCEIVE NOTHING IMMEDIATELY BUT OUR OWN IDEAS," and his argument may be conceived as continued in this chain.

N " We cannot have any knowledge of external
" exiſtence but by perceiving it immediately or
" mediately; external exiſtences are not ideas,
" therefore not perceived immediately, therefore
" not known by immediate perception. We
" cannot have any knowledge of external things,
" mediately, by means of our ſenſations, ſince
" in

" in our ſenſations we perceive nothing but the " ſenſations themſelves, and nothing without us " which is not a ſenſation, can have any reſemblance to ſenſation, nor can be brought to " our knowledge by means of that to which " it has no reſemblance; therefore we cannot " perceive external exiſtences immediately or " mediately, therefore cannot know them."

He rejects the exiſtence of primary qualities without us, alſo, on this ground, that ſolidity, extenſion, figure, and motion, have nothing in them uniform and permanent; the ſame thing may be hard and ſoft to different organs; the ſame motion ſwift and ſlow; and the ſame extenſion great and ſmall, in different relations: for example, the ſwift motion of a mouſe would be a ſlow pace for a camel; the ſize of a large dog would be very ſmall in a horſe. The ſame figure may be ſquare, globular, and flat, to different views; hence he infers that theſe qualities cannot exiſt at all without us, ſince they exiſt in no one particular manner. O

He ſays, THINGS do really exiſt without us; P but by THINGS he means IDEAS, becauſe he knows of no other THINGS; and as exiſting without our mind, they can exiſt only in another mind which perceives them, becauſe ideas cannot exiſt but as being perceived.

Q To prove the direct agency of a ſuperior mind, and get rid of mediate cauſes, he endeavours to prove that all our ideas are PASSIVE, that all our knowledge of ACTION is from our own volition; that, conſequently, ſince certain actions are performed on us without our volition, they are performed by another and ſuperior volition without us.

R To the opinion of a ſecondary agency, as an inſtrument employed by the ſupreme mind, he oppoſes, firſt, the want of any knowledge of ſuch an inſtrument, becauſe our ideas, which are all we know, are not inſtruments of themſelves: next the unreaſonableneſs of ſuppoſing God to uſe an inſtrument, becauſe an inſtrument, he ſays, always implies weakneſs. We do not uſe a lever or pulley when we can eaſily effect our purpoſe by our hand alone.

S He takes pains to ſhew that theſe notions are not repugnant to the common ſentiments of men; but avers, that the philoſophical notion of an unknown, inert ſubſtratum, as maintained by Locke, is ſo ([a]).

---

[a] See Dialogues between Hylas and Philonous.

T I ſhall firſt bring into queſtion the principle on which this ingenious writer builds his whole ſuperſtructure, 'THAT WE PERCEIVE NOTHING 'BUT OUR IDEAS.'

U This poſition at firſt ſight may appear evident, becauſe the expreſſion to perceive ideas is familiar; but on examination it will be found to be, at leaſt, inaccurate, and that inaccuracy, which the reaſoner ſhould have corrected, becomes a baſis for erroneous deductions.

X I mean, then, to ſhow that ideas are not, as this author takes for an axiom, the only objects of our perception, nor are they all, in ſtrictneſs, OBJECTS of our PERCEPTION.

Y When we ſpeak of an object of perception, or a thing perceived, we diſtinguiſh between the object and the perception; between the thing, and the perceiving that thing. If we perceive ideas, ideas muſt exiſt, diſtinct from our perception. But our author, in another place, inſiſts that ideas have no exiſtence otherwiſe than as perceived; then, if their exiſtence conſiſts in being perceived, they are not diſtinct from the perception; but if not diſtinct from it they are the very perception itſelf.

z We do not, then, perceive ideas or ſenſations, theſe are the *very* perceptions, not their objects. To have an idea, is to perceive, but it is not to perceive the idea; the idea conſtitutes the perception. Since, therefore, we cannot be ſaid to perceive any idea, we muſt, in every idea perceive its cauſe, and by the perception of the cauſe, acquire the idea.

A Although the cauſe is diſtinct from the ſenſation it produces, we do not perceive the cauſe as diſtinct, we perceive it only in and by the ſenſation, and in the ſenſation only do we diſcover and know the cauſe; hence we conclude, that ſince the objects of our perceptions are not ideas, that is, are not the perceptions themſelves, but their external cauſes, we do, immediately, perceive, and know external objects.

B Theſe objects are, reſiſtence, extenſion, figure, and motion, perceived by ſenſe, but themſelves not ſenſations. As we are capable of moving our own limbs by volition, we diſcover reſiſtence when we *will* the motion and it does not take place; as, if a man's hands are bound together, he finds the reſiſtence of the cords by his inability to ſeparate his hands, and this reſiſtence is diſtinct from the ſenſation of hardneſs: it is not a ſenſation, but the negation of an accuſtomed ſenſation, which the motion would have excited. Reſiſtences have certain limits, we do not find them every where; a poſt reſiſts me in one direction, but by a little deviation I move freely. The variety of theſe limits, and their relations, are extenſions; from extenſion of neceſſity reſults figure. Thus reſiſtence is diſcovered by motion impeded, and reſiſtence being limited and various, implies extenſion and figure. Now motion is without us; for ſince any particular idea is not always within us, its cauſe is not always within us; in producing the idea the cauſe from without muſt have entered within; the cauſe muſt, therefore, have moved without us, from where it was, in order to arrive within us, where it was not. Motion is therefore really without, if by without we mean any thing; therefore the reſiſtence, extenſion, and figure, are alſo without us.

To the objection that all theſe things are variable, and having no particular and fixed being, have no being (P 67), ſince, for example, the ſame motion may, in our *ideas*, be both ſwift and ſlow, but cannot be *actually* both, there is really no motion; I reply, this makes as much againſt motion exiſting in idea, as externally; for if a motion can, as the objection ſuppoſes, be both ſwift and ſlow in idea, it can be ſo independent c pendent on our idea, ſince whatever can be conceived, is poſſible to be. Relations are permanent only to the ſame relative objects, and variable to varying objects. A motion may be, at once, both ſwift and ſlow, compared to two other motions, but compared with the ſame motion it is permanently the ſame. If we take the relation in which a man may ſtand: to John, he is a father, to Peter, a ſon, to William, a maſter, to James, a ſervant, to George, a ſubject, to Frederic, a king. Has this man no exiſtence, becauſe in our ideas he is father and ſon, king and ſubject? And is there no father, ſon, maſter, ſervant, king, or ſubject, becauſe they are all found in one man? So we muſt conclude on the premiſes which deny motion becauſe the ſame motion is at once ſwift and ſlow.

D The ſame anſwer will apply to the ſame objection, concerning reſiſtence, figure, and extenſion; all of theſe are neceſſarily variable in relation to different objects, and permanent to the ſame objects. Any individual thing has indefinite different magnitudes relative to indefinite other different magnitudes; every one of theſe is real, that is a real relation to its proper object.

E Since, therefore, things which are not ideas do exiſt without us (P 67), to wit, the actions which produce ideas, there are external exiſtences independent on being perceived by us.

The poſition that all our ideas are paſſive F
(Q 68) is contrary to ſelf-evidence. Are not all our ideas changes taking place in our conſciouſneſs? And can change exiſt without action?

We are, it is true, paſſive ſubjects of the G
action in which ideas conſiſt; but to call the ideas paſſive is to talk of a paſſive change, virtue, or power. Let us illuſtrate this by an example taken from our author.

He ſays, "When I ſtir my finger it remains H
"paſſive; but my will, which produces the "motion, is active." How does it appear that the will is active? By producing motion, ſays our author; then whatever produces motion is active? And does not the finger produce motion as well as the will? Does it not move the air or other bodies which the will cannot move, as it can the finger? Is there not the ſame evidence of action in the finger as in the will? If the finger is paſſive to the will which moves it, is it not alſo active to thoſe things which it moves?

I But it was neceſſary to prove MOTION not to be ACTION, in order to exclude ſecondary cauſes, and eſtabliſh the notion of the direct agency of Deity; Berkley therefore argues in this chain: "First, "Are we not paſſive in all our ſenſations? Can "we avoid ſeeing when we open our eyes, or "feeling when an object touches us? Secondly, "Are not therefore all our ideas perfectly paſ-"ſive and inert, including nothing of action in "them? Thirdly, And are ſenſible qualities "any thing elſe but ideas? Fourthly, And is "not motion a ſenſible quality? Fifthly, Con-"ſequently no action."

K To each of theſe inquiries our author makes his antagoniſt aſſent, and the concluſion is undeniable; but we cannot extend our complaiſance ſo far. Admitting the firſt poſition, the ſecond is no conſequence; we are paſſive in receiving our ideas, our ideas are not therefore paſſive; paſſion implies action, and the idea is the action, of which we are the paſſive ſubjects. The marble is paſſive in the hands of the ſtatuary, but it is by means of actions it aſſumes various figures. Thus the very firſt ſtep from the premiſes is erroneous. The next "Are ſenſible qualities "any thing elſe but ideas." We have ſhewn that *ſome* ſenſible qualities are external objects of ſenſe, not ideas, and among theſe, motion is one: thus his ſecond ſtep is alſo denied. Ideas are not paſſions, but actions; but if they be paſſions, motion is ſomething more than an idea, it is proved to be action; conſequently, the concluſion that motion is no action is proved to be erroneous.

Since, therefore, motion is action, and motion does not depend always on our will, we are acquainted with other actions beſides thoſe of our volition (Q 68). L

Hence is deſtroyed the ground on which our author inferred a direct ſuperior volition without us, in all thoſe actions which our volition did not perform. M

He ſays, " If motion be no action, can you " conceive of any action beſides volition ?" But motion is action, therefore the premiſes are done away. N

The objections (R 68) againſt a mediate inſtrument, or ſecondary cauſe, are already, in great part removed, ſince we know, in fact, of ſuch an inſtrument. O

If, by my volition, I produce a motion, that motion is not a volition, but it produces another P motion, and is, therefore, an intermediate agent, an involuntary and ſecondary cauſe.

Q The other objection, ‘ that it is unworthy of ‘ Deity to ſuppoſe him employing an inſtrument,’ takes a ground on which human reaſon is very incompetent; and it will have no weight, if it can be proved that, in fact, the Deity does employ inſtruments.

R I aſk, therefore, is not the human mind created to ſome end ? And is it not an inſtrument to the end for which it was made ? God therefore employs inſtruments to his ends. Why not, then, an inſtrument to act on mind, as well as mind the inſtrument to ſome other end. God can produce ideas in mind without ſecondary cauſes. Could he not have brought about the end to which mind was created without this means ? The inſtrument here ſhows will, not weakneſs. Why not an inſtrumental univerſe as well as inſtrumental minds ? And how, from our uſe and need of inſtruments can we preſume to form a poſitive inference to the Deity ? Can we trace the connecting chain ?

S Berkley admits an external cauſe of ſenſation, but contends, that that cauſe is Deity alone: we imagine there is a mediate power, unintelligent, directly operating upon our minds, and producing according to regular laws, changes in the mind, of which changes it is conſcious, and which are its ſenſations, and one ſource of its ideas ([b]).

We ſay then, that, although we find in each, T and every individual ſenſation, a power producing and an action exerted, yet that agency is not ſuch as leads us to infer the direct operation of intelligence. We conceive of intelligence, only by attention to our own minds, and there is nothing in any colour, taſte, ſound, feeling, or motion, which implies any thing analagous to our mental operations, or to volition. I ſay there is nothing in theſe ſenſations individually, which implies the direct preſence of a thinking mind.

Therefore, in theſe ſenſations not diſcovering U the traces, not ſeeing the characters of intelligence, but finding only action preſent and neceſſary, our inferences go no further than our obſervations warrant us to do, and we conclude in all theſe things an action only, and that action unintelligent.

---

[b] A ſenſation may be defined, a conſciouſneſs accompanying an external impreſſion; an idea is a preſent conſciouſneſs of a paſt impreſſion, external or internal.

We

X We do not conſider whether God could, without any inſtrument, have produced all our ideas, and given to us that perception which we have of an eſtabliſhed order of nature: without doubt we ought to admit he could.

Y But this poſſibility admitted affords no juſt grounds for the concluſion that he has done ſo, againſt the ſtronger evidence of reaſon and facts that he has not.

Z What is it, then, from which we can infer intelligence? We know intelligence intuitively, by our own conſciouſneſs; we infer it, without us, by perceiving effects, ſuch as we find our own intelligence produces. IT IS BY AN ORDER OF SUCCESSIVE EVENTS LEADING TO AN END, that we infer intelligence, becauſe ſuch is the operation of our own intellect.

A Although we diſcover no intelligence in any one ſenſation, and can infer none in the agent which directly produced it, yet in the order and concatenation of events we gather this idea, and by this order it is that our minds are led through the intermediate, ſubordinate, and unconſcious agency, manifeſt in individual appearances, to a directive, governing, ſupreme intelligence, Nothing in this idea ſhocks our reaſon, or offends our moſt exalted ſentiments of Deity. We are not, indeed, to make our ideas of dignity any ground of inference to Deity; but neither can we admit of ſuch ideas as to ourſelves appear low, and unworthy; and it ſeems to me, that a ſubordinate agent, conſtructed as the matter of creation, inveſted with perpetual laws, and producing agreeable to thoſe laws all the forms of being, through the varieties of which inferior intelligences can, by progreſſive ſteps, arrive ultimately at the ſupreme contriver, is more agreeable to our ideas of dignity, and tends to impreſs us with more exalted ſentiments, than viewing the Deity directly, in all the individual impreſſions we receive, divided, in the infinity of particular events, and unawful, by his continual preſence in operations, to our view inſignificant and mean. B

There is one more argument in proof of a mediate agency, which, I think, alone concluſive, as it ſhows the contrary, if admitted, leads to conſequences which, aſſuredly, no one will defend. C

Whoever denies the inſtrumentality of a mediate cauſe, and aſcribes all his ſenſations to the direct volition of the ſupreme intelligence, muſt, D conſiſtently with his principles, deny the exiſtence not only of body, but of all other minds beſides his own, and that from which he receives his ideas. If he denies that a material world exiſts without him, a globe of earth, ſtars, planets, mountains, trees, houſes, and the bodies of animals, he muſt of neceſſity deny the powers with which theſe corporeal forms are endowed. If no ſun, nor earth, no gravity to preſerve the ſyſtem; if no vegetable world, no principle of vegetable life to govern it; if no material animal forms, no ſpirits to preſide over them; if no bodies of men, no ſouls to inform them, he muſt be himſelf the only object in creation, a ſolitary creature, to whom the ſupreme mind has thought fit to impart a certain order of ideas from his own eſſence, preſenting to him the glorious picture of the univerſe.

E The exiſtence of any other mind like his own muſt to ſuch a man be as unknown as are the inhabitants of the Georgium Sidus; he being altogether excluded from any commerce with them, and they with him. Since to every mind God immediately communicates from himſelf all its ideas, all intercourſe with each other is cut off, every one is an iſolated being in creation, and muſt conclude himſelf the only favoured communicant of Deity.

For if he concludes all the appearances he F ſees of human bodies, performing certain motions, are only ideas WITHIN him, how can he aſſign to each of thoſe bodily forms a ſubordinate mind like his own, exiſting WITHOUT him? If the bodies are within him an idea only, the mind appertaining to thoſe bodies muſt be within thoſe ideas which are within his mind. But if he allows of external ſubordinate minds, how does he infer them? How from ſenſible appearances, which are all within him, can he be led to beings without him, which are inſenſible? By what medium does he acquire a knowledge of theſe external minds?

His own body is, with him, merely an in- G ternal idea; other bodies the ſame. He is conſcious of volition and agency, by which certain ideas are, in a degree, within his own power; he is ſubject to other impreſſions or ideas not in his power to control; he thence infers a ſuperior volition to his; but theſe ideas in which he is paſſive are within; the volition, therefore, which directs them muſt operate within him, and cannot lead him to any knowledge of minds without.

Laſtly, the premiſes on which our author H reaſons againſt the exiſtence of a ſecondary cauſe without us, go, if admitted, to the rejection equally of a primary. He rejects the exiſtence of external matter, becauſe we can have no knowledge of it, all our knowledge being confined to our internal ideas; for the ſame reaſon we can have no knowledge of an external Deity, nor does the way in which he reaſons to the knowledge of a Deity do away the charge of inconſiſtency with his principles. 'We perceive,' he ſays, 'our volition to be action, and we perceive actions which are independent on our volition; but as we do not know any agent but volition, thoſe actions which *we* do not will ariſe from an *external* will.' But we do not perceive or feel that external will, as we do our own volition; we cannot, as it is without, know it by our ideas within. The actions from which he infers an external volition, are they not ideas within him? And if they ariſe within him, independent on his will, he cannot ſee their derivation or origin; they are to him original ideas. He cannot trace them to a will without him, of which he can have no knowledge; there is no chain from within to without; all his knowledge exiſts, ariſes, and ends within himſelf. If he ſays he infers a will without him becauſe the ideas independent on his own will *muſt* have an origin in ſome will, how does he know that thoſe ideas which he does not perceive to ariſe from volition *muſt* ariſe from volition? This is mere hypotheſis, aſſerting for knowledge what he does not *perceive*, and therefore cannot know. Without an external *paſſive* exiſtence no proof can ariſe of external *action*, and only through a world without us, can we trace the all-governing mind. It is the magnitude of creation which gives us correſponding impreſſions of the greatneſs of its author, and by contracting all things into ideas within a human mind, we contract our conceptions of Deity into the ſame narrow point of view.

Thus I have endeavoured to remove ſuch objections from pre-conceived opinions, as might lay againſt the belief of an active, unintelligent ſubſtance, the exiſtence of which I have already proved, and ſhall proceed to confirm by new evidences.

C H A P. VII.

The active Subſtance an immaterial Exiſtence, not Mind, but intermediate, and related to Matter and Mind.

A ALL exiſtence muſt be either material or immaterial, ſince immaterial implies only the negation of thoſe qualities which conſtitute matter, and comprehends all exiſtence in which thoſe qualities are not found, and which, therefore, is not matter.

B But every being is not neceſſarily either matter or mind, becauſe each of theſe terms implying poſitive characters, whatever ſubſtance may be conceived to want thoſe poſitive characters, and to poſſeſs others, different from either, will belong to neither of theſe heads, but will be a diſtinct order of exiſtence.

C Matter is a being, as a whole quieſcent and inactive, but conſtituted of active parts, which reſiſt ſeparation, or cohere, giving what is uſually denominated ſolidity to the maſs.

Mind is a ſubſtance which thinks. D

A being which ſhould anſwer to neither of E theſe definitions would be neither matter nor mind, but an immaterial, and, if I may ſo ſay, an *immental* ſubſtance.

Such is the active ſubſtance which we have F diſcovered by the above analyſis of matter and motion ; we have already concluded it to be unintelligent (υ 77), becauſe we have no grounds from whence to infer that it thinks; it therefore is not mind, neither can it be matter; for being that which reſults from the analyſis of matter, it would be abſurd to ſay, that matter was by analyſis reſolved into matter, ſince that is no analyſis which diſcovers nothing beyond the thing propoſed to be analyzed. Coheſion is an effect, in which we diſcover an active cauſe, and thence infer an active ſubſtance; but this active ſubſtance cannot be a cohering ſubſtance, for then the coheſion would ſtill be an effect of which we ſhould have to ſeek the cauſe, and we ſhould have made no advance towards diſcovering the cauſe of coheſion. The elementary principles of things muſt be different from their compounds, and muſt, themſelves, be without thoſe properties which the compounds derive from the union of the principles; the active ſubſtance therefore is devoid of coheſion, or, what is called, ſolidity; wanting this, it wants that ſort of action among its parts which conſtitutes coheſion; but ſince it is an active ſubſtance, and has not thoſe actions of its parts which matter poſſeſſes, producing inertia of the whole, it muſt have ſome other action, to wit, an action as a whole quantity. Thus it is without coheſion, which matter poſſeſſes; and is poſſeſſed of activity as a whole, of which matter is deſtitute; it wants therefore the poſitive characters of matter, and poſſeſſes another character which matter does not poſſeſs (B 84), it therefore is not material.

G This ſubſtance, neither mind nor matter, is, in ſome reſpects, related to both, and may be conſidered as an intermediate exiſtence; it is related to matter inaſmuch as both the active ſubſtance and matter are active, although in different manners; the activity of the one being the reſult of the activity of the other, as a compound reſults from the union of its elements. It is related to mind alſo, as both are in certain manners active, and as both have the negative quality of immateriality.

H If it be alleged that ſuch a ſubſtance is a new order of being, I reply, as far as I know, it is;

but I do not ſee in this, any argument againſt its exiſtence. We do not, here, propoſe to record ancient opinions, or deliver eſtabliſhed ſyſtems, but ſeek, by the exerciſe of reaſon, to improve the ſtate of ſcience; the doing of which neceſſarily implies both the renunciation of former errors, and the diſcovery of new truths.

We might, in the extenſive ſenſe in which the ancients applied the term mind, call the ACTIVE SUBSTANCE the MIND of the univerſe, and in every particular thing, the mind of that thing; the active principle by which a mountain coheres and gravitates, by which a bullet flies, the earth moves, and a tree grows, would be the mind of the mountain, the bullet, the earth, and the tree; for they, in general, termed all active principles mind: but this ſenſe of the word is not in common adopted, in the preſent day; and it is both more ſafe to adhere to general uſage, as far as poſſible, and important to diſtinguiſh by different appellations, things ſo different as thinking and unthinking ſubſtances.

PART

PART II.

Of Action, and the Manner in which the ACTIVE SUBSTANCE *produces Matter and Motion, inveſtigated by Inferences from Effects to Cauſes.*

INTRODUCTION.

THE analyſis attempted in the firſt part is to be conſidered leſs as a work of reaſoning than of obſervation. It is a decompoſition of ſenſible impreſſions, unravelling the intricacies of our compound ideas, and bringing them into a ſimple point of view. We laid down no data from which to reaſon, but merely examined and developed by a kind of mental experiment, the various ideas received through our external organs. It is intended, in great part, to ſhow a very ſimple and obvious fact, that matter and motion are active; but this evident fact being denied in a favourite ſyſtem, oppoſed by ſtrong prejudices, obſcured by an ingenious converſion of terms from their genuine import, and the truth born down with the weight of an authority to which the age yields an implicit faith; theſe things rendered it expedient to inveſtigate minutely, and turn on every ſide, a poſition, which, but for them, would have carried its own evidence.

B We conſider it now as a fact eſtabliſhed, that every thing in nature is active, and the inference from hence that all things exiſt, and all changes are produced by an ACTIVE SUBSTANCE, is alſo aſſumed as a datum. Upon theſe premiſes we ſhall now proceed to inveſtigate further the nature and laws of the ACTIVE SUBSTANCE, in producing the phenomena of the world, by drawing evident and undeniable inferences from effects to their cauſes.

C When, however, we ſpeak of ACTION as univerſal, it is always to be underſtood that there are certain ſenſes in which every thing may be ſaid to be INACTIVE. Every thing is active, but not active in every manner; and a right knowledge of theſe diſtinctions is eſſential to juſt conceptions of nature.

CHAP.

CHAP. I.

On the Rules of Reaſoning from Effects to their Cauſe.

THE knowledge of the connections that link events together, and conſtitute a continued chain in nature, is the ſum of philoſophy. A

A CAUSE may be defined an event which neceſſarily precedes another; an EFFECT is that other event which is neceſſarily preceded by the cauſe, and neceſſarily follows it. B

There is no ſmall obſcurity pervades almoſt the whole of phyſics in reſpect to the diviſion and doctrine of cauſes; and to this obſcurity the imperfect and undecided ſtate of theoretical knowledge is owing. As it is our purpoſe to endeavour to advance forward in ſcience, we propoſe to lay down ſuch rules as may conduce ſomething to this end, rather than follow thoſe heretofore eſtabliſhed. C

D The rules of reaſoning in philoſophy, as laid down by Sir Iſaac Newton, and generally adopted, are as follow :

Firſt. *To admit of no more cauſes of natural things than are both true and ſufficient to explain their appearances.*

Secondly. *Therefore to the ſame natural effects, the ſame cauſes muſt, as far as poſſible, be aſſigned.*

Thirdly. *Qualities which admit of no change in degree, and are found in all bodies as far as we can obſerve, are to be eſteemed univerſal.*

Fourthly. *Propoſitions collected by induction from phenomena are to be admitted before any contrary hypotheſis.*

E These rules are, no doubt, juſt and uſeful, as far as they go, but they appear to me to be imperfect; they are calculated, indeed, for that foundation of philoſophy on which Sir Iſaac propoſed to reſt his inquiries, *experiments*; but are inadequate to the more extended purſuits of rational inveſtigation. . The firſt rule requires that we ſhould admit no more cauſes of natural things than are both true, and ſufficient; but by what *rule* are we to determine concerning the TRUTH and SUFFICIENCY of cauſes? Surely a rule to conduct ourſelves in theſe points is the moſt important of all; for it is to no end that we conſent to admit of that only which is true and ſufficient, if we have no ſtandard whereby to determine what are to be conſidered as having theſe requiſites. Here is therefore a fundamental deficiency in theſe rules, a deficiency which expoſes us to every ſort of deluſion and error; they only direct us to follow a ſingle path rather than many, and command that this path ſhould be the right one, but give us no marks whereby we may diſtinguiſh the right path from many others, which are wrong.

It is probable, indeed, that in a philoſophy propoſed to be built on experiments alone, experiments would be conſidered as the only teſt of the truth and ſufficiency of cauſes; but this precludes all inveſtigation purely rational, and can therefore avail us nothing in ſuch an attempt. At the ſame time, if experiment be conſidered as the only teſt of the truth and ſufficiency of cauſes, it muſt be obſerved, that our author in forming his firſt principles deviated from his own rules; for it was not poſſible to eſtabliſh thoſe principles by experiment; and they are purely reſults of a mental proceſs, I will not ſay of reaſoning, becauſe I think them repugnant to reaſon,

ſon, and regard them as hypotheſes fabricated in the mind to explain appearances. I ſpeak here of the VIS INERTIÆ, OR INERTIA of matter, a principle incomprehenſible in itſelf, and wholly incapable of an appeal to experiment; and the VIS IMPRESSA, or principle of action, which, as defined and explained, is equally obſcure and unfounded in fact. This incongruity, into which Sir Iſaac has fallen, cannot be too much inſiſted upon, becauſe it affords a ſubterfuge for error, and perplexes the minds of inquirers, who continually recur to the plea, that the Newtonian philoſophy is ſounded on experiments, and that its principles are only the aſſertion of indubitable facts, when the truth is the very contrary. Sir Iſaac does indeed in ſo many words diſclaim and renounce hypotheſis, and profeſſes to be guided only by facts; but his firſt principles, even if true, cannot be pretended to be facts, they muſt be rational truths, defenſible by reaſon as deductions from facts: but to this kind of proof, we have, in another work, ſhewn they can lay no claim.

G What appears to be yet wanting in phyſics, is ſome teſt more certain, and more general, than has as yet been given of the truth and ſufficiency of cauſes; and to attempt to ſupply this deſideratum, let us examine further, what is the nature of the relation of cauſe and effect.

The neceſſary connection between two events, one being prior, and the other ſubſequent, conſtitutes the former a cauſe, and the latter an effect. H

Under this general character ſeveral kinds are included, which may, for the moſt part, be comprehended in the four following, rational, experimental, remote, and proximate. I

The connection between cauſe and effect may be *perceived* by the mind: thus the ſolution of ſugar in water is a cauſe of ſweetneſs in the water; the connection is traced in the contemplation of the divided parts of the ſugar diffuſed through the water, and imbuing it with its own quality. Or the connection may be *unperceived*, as in the change of ſaccharine ſubſtances into ardent ſpirits, in the vinous fermentation. When the connection is unperceived, the mind *infers* the connection *a poſteriori* from the fact obſerved; we conclude cold to be the cauſe of the change of water into ice, not becauſe we perceive the connection between cold and fixedneſs, but becauſe we perceive in fact the two events, a certain degree of cold, and K and the production of ice, do always happen in the order of prior and ſubſequent.

L This diſtinction gives us two ſorts of CAUSES, which we may denominate RATIONAL and EXPERIMENTAL. The rational, being thoſe whoſe connection with the effect is perceived; the experimental, thoſe where it is only inferred from the fact firſt experimented.

M Of theſe two it may be obſerved, that the former affords us grounds for reaſoning *a priori*, and for rational proofs, in caſes where the opportunity of making experiments may be wanting. Knowing water to be a ſubſtance devoid of colour, taſte, and medicinal qualities, we can certainly infer, *a priori* any colour, taſte, or medicinal quality to be imparted to the water, by a ſolution, in it, of known ſubſtances. The latter admits of no reaſoning apart from experiments; we cannot draw a ſingle inference without hazard of being wrong, but muſt, at every ſtep, make trial of the fact, to aſſure the truth of our proceedings. We cannot from the ſight, ſmell, or taſte, aſſure ourſelves of the nutritive, or deleterious qualities of any unknown plant, but muſt make the experiment before we can determine.

Another diſtinction between cauſes and effects is into REMOTE and PROXIMATE. In a chain, each link is connected immediately to the link neareſt to it, and remotely to others at a greater diſtance. Events ſucceed to each other in nature in a certain ſeries; each event is connected immediately to that which directly precedes, and directly follows; and remotely to others, ſeparated from it by a greater or leſs number of intervening events. The remote cauſe of an eclipſe of the ſun is the force by which the moon performs certain motions relative to the ſun and earth; the proximate cauſe is the interpoſition of the moon's body in a line between the ſun and earth. N

There are other varieties among cauſes, which I ſhall not minutely inveſtigate. Several links may be connected remotely or immediately with one; ſeveral cauſes remote or proximate may concur to one effect, and concur in different degrees, and different manners. Hence, cauſes may be diſtinguiſhed, as they are predispoſing, occaſional, inciting, partial, primary, ſecondary, efficient, mediate, and an abundant diverſity of others, which accurate obſervations would lead to diſcriminate. O

P I have only to conſider the diſtinction of cauſes as they are experimental or rational; and to one or the other of theſe heads all cauſes belong. Experiment is the only ſtandard of experimental cauſes; when we ſee an event uniformly followed by another, we are ſatisfied the former is a cauſe of the latter, both TRUE and SUFFICIENT, although we do not perceive how the two events are connected, nor in what conſiſts the ſufficiency of the cauſe; we *infer* that the connection does exiſt, and the fact proves the cauſe to be a ſufficient one. But when we *reaſon* to the diſcovery of a cauſe, and either decline or are unable to employ experiments, we muſt have a different ſtandard of what is true and ſufficient.

Q This ſtandard can be no other than the *perception* of the neceſſary connection between events; in other terms the *perception* of ſomething in the cauſe, which involves the effect; for ſince, in this caſe, all experiments from which the CONNECTION between events can be *inferred*, are precluded, that CONNECTION can no otherwiſe be known, than by being perceived as an intuitive truth.

R Hence, when the cauſe of any effect is ſought, if we can, by experiment, aſcertain what appearance,

pearance, or event, always, and directly, precedes the effect, we ſhall have found an experimental cauſe. If we can *perceive* what it is which neceſſarily and alone involves that effect, we ſhall have diſcovered its rational cauſe: for example, impulſe is an experimental cauſe of motion, but not a rational one, ſince we do not *perceive* how the impulſe of one body involves the motion of another; but if beſides the impulſe, as it appears to ſenſe, we can find an idea which does neceſſarily, and alone, involve the motion of the impelled body, this idea will be the rational cauſe of the motion in this body; it will be TRUE, becauſe the idea perceived being the only one which involves the effect, *that*, and no other muſt be the cauſe; it will be SUFFICIENT, becauſe it does actually involve the effect.

If one, of two diſtinct ſubſtances, poſſeſſes a quality, of which the other is wholly a privation, the union of theſe two ſubſtances neceſſarily implies, in the whole, formed by the union, the preſence of that poſitive quality, which, before the junction, belonged only to one ſubſtance. Thus whiteneſs being a combination of all the primitive colours, is conſidered as a privation of each ſingle colour; the union of any primitive colour therewith imparts to the whole, thus united, the poſitive colour, red, orange, blue, or green, which has been incorporated with the white. Water is a privation of ſweet, bitter, acid, or of any medicinal quality; a ſubſtance poſſeſſing any of theſe qualities, being diſſolved in the water, the new maſs poſſeſſes the actual qualities, which the diſſolved ſubſtance has ſuperadded to the privation of them, in the water.

T And, in general, from the combination of a ſubſtance, having a poſitive quality, with one which is a privation of that quality, we infer the preſence of that poſitive quality, in the whole compound. Thus we argue from the cauſe, the incorporation of the two ſubſtances, to the effect, the preſence in the whole compound, of the quality, of which, before this union, one ſubſtance only was poſſeſſed, and one deſtitute.

U If a ſubſtance, in its own nature devoid of a certain quality, be found accidentally poſſeſſed of that quality, we neceſſarily infer that the new quality has been ſuperadded, and the ſuperaddition of the new quality implies, alſo, the preſence of the ſubſtance to which that quality belongs, ſince no quality can exiſt apart from its proper ſubſtance.

X Thus, if a maſs which before was white, becomes red or blue, we infer that ſome ſubſtance, red, or blue, has been mingled with the white. If water, before inſipid, and unmedicinal, acquires taſte or medicinal qualities, we infer the addition of ſome ſubſtance from which the quality has been imparted.

y The ſame neceſſary connection with the former (T 100) is here traced in an inverted courſe. From the preſence of a new, and accidental quality, we infer the preſence of the ſubſtance in which that quality inheres. Here we argue from the effect, the new quality apparent, to the cauſe, the ſuperaddition of that quality, by the junction of a foreign ſubſtance, to which it belongs.

z We can have no other ground of inference than this, the change of ſome quality, either in figure or place, and aſſuming a new form, or being united to a new ſubſtance. We cannot conceive of any thing, as bitterneſs, pain, or motion, being produced from nothing, nor can we conceive of one thing, as ſound, being produced from a different one, as odour, or of motion, as proceeding from reſt. An effect, which is only a new appearance, of ſomething *where* it was not before, or in a *manner* in which it did not before appear, can only be comprehended by ſuppoſing the thing did before exiſt, and has, in order to the production of the effect, arrived into a new ſituation, or has aſſumed a new modification, or figure. Probably we ſhall never comprehend how motion produces ſenſation, becauſe in motion we perceive nothing that can, by any change of place or figure, involve ſenſation.

From what has been ſaid, we may lay down the following rules in the inveſtigation of rational cauſes, from their effects.

RULE I.

A A RATIONAL CAUSE MUST CONTAIN IN IT THE NATURE AND QUANTITY OF THE EFFECT.

For otherwiſe, in the effect, a new nature or a new quantity, muſt be produced from nothing, which is what we cannot comprehend, and therefore cannot admit.

RULE II.

B A RATIONAL CAUSE MUST BE PRESENT IN TIME AND PLACE WITH ITS EFFECT.

RULE III.

C WE ARE TO ADMIT OF BUT ONE RATIONAL CAUSE.

For when reaſon is ſatisfied with one, to what end ſhould we ſeek for more?

RULE IV.

EFFECTS DIFFERENT ONLY IN CIRCUMSTANCE, BUT THE SAME IN NATURE, ARE TO BE ASCRIBED TO THE SAME CAUSE DIFFERENTLY CIRCUMSTANCED, AND NOT TO DIFFERENT CAUSES. D

This is a conſequence of the third rule.

RULE V.

EQUAL CONTRARIES MEETING DESTROY EACH OTHER. E

Contraries are things which cannot exiſt in union, whence the propoſition follows.

The firſt and ſecond rules are contained in the poſitive principle that we muſt perceive the neceſſary connection between a cauſe, admitted as rational, and its effect; for if the cauſe and effect differ in nature, or in quantity, in time, or in place, there is between them a chaſm through which the mind can trace no connection. The third and fourth rules belong to the negative principle, admitted in philoſophy, that we are not to ſeek ſuperfluous cauſes, or to ſuppoſe nature has done any thing in vain. The fifth rule is evident. F

CHAP.

CHAP. II.

In what Manner the ACTIVE SUBSTANCE *is active, and how it acts.*

A WE are to diſtinguiſh, here, between the activity and action of the ACTIVE SUBSTANCE, and the activity and action of bodies; the one being primary and eſſential, the other derivative and ſuperadded.

B We are alſo to diſtinguiſh between *activity* and *action: to be active*, is to poſſeſs the quality of activity, or to be capable of acting; and this may belong to *one* ſingle ſubſtance.

C *To act*, is to exerciſe the quality of activity; and to exerciſe this quality is to communicate it; for whenever we ſay a thing acts, we mean that it induces an action on ſome other thing; therefore *two* things are neceſſary to action, an active thing, communicative, and a paſſive, recipient.

We may, therefore, conſider firſt, in what conſiſts the *activity* of the ACTIVE SUBSTANCE in itſelf; and afterwards how it *acts* or communicates its own quality to another. D

Every thing muſt be, in its own nature, either diſpoſed to reſt or motion; conſequently the ACTIVE SUBSTANCE muſt be conſidered as being, naturally, either quieſcent or motive. E

But it cannot be naturally quieſcent, or diſpoſed to reſt; for then it could not be active, becauſe activity, which is a tendency to motion, cannot originate in a tendency to reſt. F

Therefore the ACTIVE SUBSTANCE is by nature motive, that is, tending to motion. G

We learn, from obſervation of bodies, two conditions in which they have a tendency to motion; theſe are actual MOTION, and IMPULSE without motion: in each of theſe conditions bodies are active or endeavour to move, the endeavour in one caſe being manifeſt by the actual motion, in the other by the force neceſſary to reſtrain the motion; and a thing cannot be conceived to have a tendency to motion without being in one, or the other, of theſe conditions. H

I Therefore whatever tends to move, muſt either actually move, or it muſt impel, without actually being in motion.

K But the ACTIVE SUBSTANCE cannot impel without being in motion.

L IMPULSE is the action which happens between ſolids, in contact, at their ſurfaces, when one impedes the others motion, on account of their mutual reſiſtence to penetration.

M But the ACTIVE SUBSTANCE is not ſolid, and does not reſiſt penetration (F 85); it is therefore, incapable of impelling or of ſuſtaining impulſe; it cannot, like bodies, reſt in certain portions, preſſing upon ſurfaces of other portions, either of its own ſubſtance, or of matter; becauſe, in every part it is permeable and yielding, and no ſurface reſiſts another.

N Therefore, the ACTIVE SUBSTANCE tending to move, and being incapable of having its motion impeded by impulſe, does actually and continually move.

O And ſince the ACTIVE SUBSTANCE continually moves, and is never diſpoſed to reſt, nor is capable of impulſe, it cannot be active in the manner of reſt, nor of impulſe, but muſt be active in the manner in which it exiſts, that is by its motion.

Since, alſo, it is eſſential to the ACTIVE SUBSTANCE to be active, and motion is the manner in which it is active, MOTION IS ESSENTIAL TO THE ACTIVE SUBSTANCE. P

The ACTIVE SUBSTANCE is *active* of itſelf, and moves of itſelf; but in order that it may *act*, ſome other thing, upon which it may produce a change, is neceſſary. Q

For whatever ſuffers an action, receives ſome change. R

The active ſubſtance in acting on ſome other thing, muſt impart and unite itſelf thereto, for its *action* is communicating its *activity* (c 104); but it cannot communicate its activity without imparting its ſubſtance, becauſe it is the ſubſtance alone which poſſeſſes activity, and the quality cannot be ſeparated from its ſubſtance. S

THEREFORE THE ACTIVE SUBSTANCE ACTS BY UNITING ITSELF WITH THE SUBSTANCE ON WHICH IT ACTS. T

U The union of this ſubſtance with bodies is not to be conceived of as a junction of ſmall parts, intimately blended together, and attached at their ſurfaces; but as an entire diffuſion, and incorporation of one ſubſtance with another in perfect coaleſcence.

CHAP. III.

On the different Origins and Circumſtances of Activity in Bodies, apparent from Obſervation.

A SOME of the apparent ORIGINS of activity in bodies are;

B VOLITION; this appears from the actions of the muſcles, which are ſubſervient to our wills, and the motion of the limbs conſequent thereon:

C IMPULSE; as appears in the motion, or action conſequent on impulſe:

D FIRE; as appears in the expanſion of air, and other bodies by its means:

ELECTRICITY; as appears in its attracting and E
repelling light bodies, and ſhattering and deſtroying larger ones, as in the effects of lightning.

The above origins are EXPERIMENTAL CAUSES, F
being events obſerved to precede, and be connected with motion as their effect.

Matter is active under certain CIRCUMSTANCES, G
when NO CAUSE OR ORIGIN is apparent: we can, in theſe caſes, only mark the CIRCUMSTANCES which diſtinguiſh one activity, of one denomination, from another activity, of another denomination; but we are not to miſtake, as ſignifying a cauſe, the term which ſerves only to deſignate the ſpecies of activity.

Among the different activities, of which we H
know no EXPERIMENTAL CAUSE, or, can by our ſenſes, diſcover no ORIGIN, we may enumerate

Thoſe of certain organized ſyſtems which we I
denominate LIFE; as in living animals and vegetables.

Thoſe whereby bodies merely approach towards K
or recede from others: as bodies approach to the earth; iron to the magnet; as

two ſimilar poles of a magnet recede from each other. The actions on which theſe motions depend are called in general ATTRACTION and REPULSION; the particular attraction towards the earth is called GRAVITY; and of the ſmall parts of bodies to each other, COHESION.

L Thoſe whereby bodies, whoſe figures are changed, reſtore themſelves to their former figures, termed ELASTICITY.

M We might diſtinguiſh other varieties of activity, were it important to do ſo; but all of them belong to one or the other of theſe two heads; thoſe where an EXPERIMENTAL CAUSE is manifeſt, and thoſe where NO CAUSE AT ALL is diſcovered by the ſenſes.

N And here it is proper to notice a prevailing error, in making words ſtand for names of CAUSES of motion, which, in fact, can only ſerve to diſtinguiſh the SPECIES, there being no CAUSE diſcovered. The motion of the ſmall parts of bodies approaching each other to cohere; the motion of the iron to the magnet; the motion of bodies towards the earth, may, very well, be diſtinguiſhed from each other, and from other motions. If we called them all, in general, attractive motions; one, attraction of coheſion; an other, attraction of magnetiſm; the third, attraction of gravitation; to theſe names, as diſtinguiſhing ſpecies and differences, no objection could ariſe: but when we change the mode of expreſſion, and ſay, attraction is the CAUSE of coheſion, of magnetiſm, and of gravity; the terms ſerve for a very different, and a very exceptionable purpoſe; they are no longer names of things perceived, to wit, motions or tendencies, but they become names of imaginary, and unknown things; of things unperceived by ſenſe, and unconceived in the mind. When, for example, it is ſaid the parts of bodies cohere *by* an attraction, what idea have we of the thing ſignified by attraction? If we ſay bodies tend to the earth *by* their gravity, what idea have we of this gravity? But if we define the term gravity to ſignify the actual tendency of bodies to the earth, and ſay they gravitate *by* attraction, then what do we mean, different from the fact of gravity, by attraction? We muſt give a name to every known fact, whether cauſe or effect; but we ought not to give a name to a cauſe while it is unknown either as experimental or rational; for this is to uſe a word without an idea, to perplex the mind, and retard the progreſs of knowledge, by a ſubſtitution of its ſemblance for the reality.

O In all thoſe motions, or tendencies, termed ATTRACTIVE, we ſee no event or circumſtance precede the motion or tendency; nothing to which, as a cauſe, we can refer the effect; the EFFECT therefore is manifeſt, but the CAUSE hidden.

P In *no* example of activity in matter is the RATIONAL CAUSE manifeſt. Among thoſe activities where we can ſee an EXPERIMENTAL CAUSE, ſuch as volition, impulſe, fire, electricity, we do not perceive the neceſſary connection between cauſe and effect; we do not *underſtand* the facts. In the other motions, we ſee, as was ſaid, NO CAUSE AT ALL; the RATIONAL CAUSE of all activity in matter, remains therefore, to be inveſtigated.

Q Whenever a body is ſubject to a cauſe of motion, or in circumſtances wherein, if left to itſelf, it would be moved, and is prevented from motion, it nevertheleſs becomes active in the direction of the cauſe, and exerts an impulſe on whatever impedes its own motion.

CHAP. IV.

Of Activity in the General, conſidered as appertaining to Bodies.

WE propoſe, now, to ſpeak of bodies as whole and entire maſſes, in which ſenſe they are, of themſelves, inactive (M 18); *i. e.* without any tendency to motion, and conſequently, whatever activity they poſſeſs muſt be derived from ſome external ſource (A, &c. 108). A

Bodies (A 104) have two forms of activity, MOTION and IMPULSE (105) ; a tendency to motion is common to both of theſe forms of activity; and all activity is, in this reſpect, ſimilar to itſelf, having only differences of direction and degree. B

Therefore, one cauſe only, differently circumſtanced, is to be aſſigned for all activity in bodies (D 103). C

The internal activities (F 24) among the parts of bodies, as well that whereby the primary parts are hard and reſiſting, as that whereby they cohere together, D together, may be called the CONSTITUENT ACTIVITIES; the former the CONSTITUENT ACTIVITY of MATTER, becauſe a primary part is the firſt and moſt ſimple form of matter; the latter the CONSTITUENT ACTIVITY of SPECIES, becauſe the manner in which parts are arranged by theſe actions, may be conceived to conſtitute the ſpecific differences of bodies.

E From theſe CONSTITUENT ACTIVITIES a CONSTITUENT ACTIVE SUBSTANCE is inferred, as the ſubſtratum of matter (I 59).

F The CONSTITUENT ACTIVITIES, by their equilibrium, leave the WHOLE of every maſs INACTIVE, quieſcent, paſſive; not repugnant to motion, nor reſiſting, but a mere privation of activity (A 113).

G Whatever other ACTIVITIES, beſides the CONSTITUENT, are found in bodies, theſe, not being innate, nor ariſing from an internal ſource, nor neceſſary to the exiſtence of bodies, but originating from without, and ſuperinduced on them ſubſequent to their formation, may be called ACCESSORY ACTIVITIES; of this kind is the activity of gravity, of magnetiſm, of animal volition, of impulſe, and all others not included under the CONSTITUENT ACTIVITIES.

THE ACCESSORY ACTIVITIES ARE SUPERINDUCED UPON BODIES BY THE ACCESSION OF A NEW ACTIVE SUBSTANCE, DISTINCT FROM THE CONSTITUENT (E 114). H

For bodies exiſt INACTIVE by the equilibrium of the CONSTITUENT ACTIVITIES (F 114); if, therefore, bodies are active, as in the acceſſory activities (G 114), ſince they are not active by their innate or CONSTITUENT ACTIVE SUBSTANCE, they become ſo by a new and ſuperadded ACTIVE SUBSTANCE.

The new ACTIVE SUBSTANCE, which induces the ACCESSORY ACTIVITIES may be called the ACCESSORY ACTIVE SUBSTANCE. I

There are, therefore in a body, two forms of the ACTIVE SUBSTANCE, one is the eſſential ACTIVE SUBSTANCE which conſtitutes the body, in a manner to be explained([a]); the other is the occaſional ACTIVE SUBSTANCE by which a body is, in any way, made active, as in gravity or projection. K

THEREFORE ALL THE ORIGINS OF ACTIVITY ENUMERATED (A 108) SERVE TO IMPART THE ACCESSORY ACTIVE SUBSTANCE TO BODIES, AND WHERE ACTIVITY IS WITHOUT ANY MANIFEST L

([a]) See Chap. VI.

FEST ORIGIN (H 109) THE ACTIVE SUBSTANCE IS DERIVED FROM AN INVISIBLE SOURCE.

M THE ACTIVE SUBSTANCE BEING IMPARTED TO A BODY, PENETRATES THE MOST SOLID OR RESISTING PARTS, AND DOES NOT RESIDE IN THE PORES, WITHOUT, AND AT THE SURFACES OF THE SOLID PARTS.

For the activity is imparted to the body itſelf, and not to its pores which are not parts of the body; therefore, if the ACTIVE SUBSTANCE remained within the pores, the cauſe would not, as is required by the ſecond rule, be preſent with its effect; but the cauſe would be in one place, and the effect in another, which is impoſſible.

N Therefore, we are to conſider of the communication of the ACTIVE SUBSTANCE, as of its forming a perfect union of its whole ſubſtance with the ſubſtance of the body; the two becoming, during this union, one ſame ſubſtance and nature; and hence it is, that the body becomes active by the ſuperaddition and union of this foreign active nature with its own inactive maſs.

O The active ſubſtance pervades and penetrates bodies without reſiſtence; for the reſiſtence of coheſion is only a reſiſtence of parts to ſeparation,

tion, and therefore to the interpoſition of other *matter* which would ſeparate the parts; but it reſiſts not to an *immaterial* ſubſtance, which enters, and fills the maſs without ſeparating its parts, itſelf having no cohering or reſiſting parts.

BODIES ARE ACTIVE ALWAYS IN THE SAME DIRECTION IN WHICH THE ACTIVE SUBSTANCE MOVES. P

For activity as a cauſe in one direction, cannot involve activity in another direction, as an effect (A 102).

THE QUANTITY OF ANY ACCESSORY ACTIVITY IN A BODY IS PROPOTIONAL TO THE QUANTITY OF THE ACCESSORY ACTIVE SUBSTANCE INDUCING THE ACTIVITY IN THE BODY. Q

For the ACTIVE SUBSTANCE *ſuperadded*, cannot *impart* more or leſs activity than is eſſential to it.

There are two ſtates of inactivity, or inactivity may depend on two different circumſtances, the *privation* or the *equilibrium* of the ACTIVE SUBSTANCE. If a body has an ACCESSORY ACTIVITY, as, an impulſe from a man's hand, when that impulſe ceaſes, the body will become, as before, inactive, and this inactivity may be conſidered as R as depending on the *privation* of the impulſe, or it may be conſidered as depending on the *equilibrium* (of the conſtituent actions (F 114), as if no impulſe had been given to it. Again, if a contrary and equal impulſe be given from another hand, the body will alſo become inactive, as if no impulſe were given to it, by the *equilibrium* of the two impulſes.

S WHEN AN ACCESSORY ACTIVITY IN A BODY CEASES, EITHER THE BODY IS DEPRIVED OF ITS ACCESSORY ACTIVE SUBSTANCE, OR HAS RECEIVED A NEW AND EQUAL QUANTITY OF ACCESSORY ACTIVE SUBSTANCE, MOVING IN A CONTRARY DIRECTION.

The body loſes its ACCESSORY ACTIVITY either by the *privation* or the *equilibrium* of the ACCESSORY ACTIVE SUBSTANCE (U 117); for ſince the quality of activity has ceaſed, either by the ſecond rule, the ſubſtance poſſeſſing that quality has quitted the body, or by the fifth, the quality has been deſtroyed by the union of its contrary.

T In order the better to underſtand the ſeveral ways in which matter may be ſaid to be active or inactive, the following conſiderations may be uſeful.

Activity in bodies may be conſidered as the activity in parts, or in the whole of any finite maſs. Coheſion is an action among the *parts* of a body; gravity, or projectile impulſe, is an action of the *whole* maſs of any body; but if we conſider gravity comprehenſively as in the whole maſs of earth, and bodies, not as *wholes*, but as *parts*, forming collectively the whole earth, then gravity is to be conſidered not as an activity of the *whole* earth, as an unit, but of its *parts* numerically. If we conſider the earth as a whole maſs, its motion in its orbit may be called the activity of a *whole* body; but if we have regard to the ſolar ſyſtem as a whole, of which the earth forms a part, then we are to conſider the planetary motions as activities of the *parts* of that inactive *whole*. Thus every maſs may be conſidered in the two characters, of a *whole*, and of a *part* of ſome greater *whole*; as the former *inert*, as the latter *active*. w

The activity which bodies have, conſidered as *wholes*, are internal. That which they have conſidered as *parts* of a greater whole, are derived from without: thus a ſtone, or any portion of the earth, conſtituted a diſtinct maſs by the coheſion of its parts, has, as a whole, no activity proper to it but this activity of parts which x which conſtitutes it; gravity, or any other activity is not eſſential to its exiſtence as a ſtone, but is ſuperadded. The earth, regarded as a whole, has its activity of gravity within and eſſential to it; for it is formed a whole only by its gravity; but the activity whereby it moves in its orbit is without, and not eſſential to it as a globe of earth. The activity of coheſion is eſſential to matter, as matter; but the activity of gravity is not eſſential to matter as ſuch, but to the earth as an earth. The activity of the earth in its orbit is not eſſential to the earth as ſuch, but it is eſſential to it as a part of the ſolar ſyſtem.

y In reſpect to its own internal activities, EVERY WHOLE may be ſaid to be *inactive*, becauſe the reſult of the internal activities of the parts is an equilibrium: the whole is active inaſmuch as all the parts are active, but not active *as a whole*, becauſe from all the activities of parts no one activity of the whole reſults.

z In this ſenſe we may ſay that every PRIMARY ATOM, every MASS OF MATTER, THE EARTH, and THE SOLAR SYSTEM, is INACTIVE, becauſe each of theſe reſpectively is *in equilibrio* relative to the activities of its own parts.

But every whole is active as a whole, relatively to ſome greater whole, of which it forms a component part (U 119). A

In this ſenſe a PRIMARY ATOM, a MASS OF MATTER, and the EARTH are ACTIVE. The atom is active relatively to the maſs it helps to conſtitute, by its coheſion to other atoms. The maſs is active relatively to the earth, of which, as a greater whole, it, by its gravity, forms a part. The earth is active in relation to the ſolar ſyſtem, and it is poſſible, the ſolar ſyſtem may be active, in regard to the larger ſyſtem of the univerſe. B

The above diſtinctions and explanations concerning action are important to be well underſtood, and kept in view. C

CHAP. V.

Of Activity in Bodies, as diſtinguiſhed into Motion and the two Forms of Impulſe, Preſſure and Percuſſion.

A A STATE of activity is ſuperinduced upon bodies, of themſelves inactive, by the union of the ACTIVE SUBSTANCE, with the ſubſtance of the bodies (N 116).

B The ſtate of activity of bodies appears under two forms, motion and impulſe: ſo the activity of gravity is manifeſt in a falling body by its motion, in a body at reſt by its impulſe.

C There are two forms of impulſe, *preſſure* and *percuſſion*; a body at reſt preſſes by its gravity, but when a falling body, or a projectile undergoes the change from motion to reſt, it percuſſes, ſtrikes, or impinges; which terms may be uſed to ſignify the ſame thing.

D Thus activity in bodies has three different forms, motion, preſſure, and percuſſion; but the ACTIVE SUBSTANCE has only one manner of being active, that is, by motion (O 106); and one mode of acting, by uniting itſelf to that on which it acts (T 107).

E It remains to be inveſtigated how the ACTIVE SUBSTANCE can by its *motion* alone, induce on bodies when united to them, the three varieties of activity, *motion*, *preſſure*, and *percuſſion*, and on what relative circumſtances of this SUBSTANCE to bodies theſe diverſities depend.

F When any quantity of acceſſory ACTIVE SUBSTANCE (I 115) is imparted to a body, the body acquires a ſtate of acceſſory activity, or an activity not proper to it, but induced upon it.

G This activity will manifeſt itſelf either by the motion of the body, by its preſſure, or by its percuſſion on ſome other body.

H If the activity of the body (G 123), be manifeſted only by its motion, the body may be ſaid to be in a ſtate of activity only, but not to act. It is in a ſtate capable of action, but has no ſubject on which to exert an action (C 104). This ſtate of a body can only be conceived of as exiſting in a motion in an unreſiſting ſpace.

I A body may be in a ſtate partly of motion, and partly of impulſe; as when moving in any reſiſting medium. In this ſtate the body is partly active, without acting, and partly acting. The *activity* of the body is as much as it either moves or impels the medium, and is equal to the ſum of the motion and impulſe; but the *action* of the body is equal to the impulſe only, ſince the action can be as much only as there is a ſubject to ſuſtain the action. A body may have the ſame *activity* in vacuo, in a rare medium, or in a denſe one; but the *action* will be different in each of theſe caſes; in the vacuum there can be no action; in the rare medium there will be leſs action than in the denſe; in the denſe more; and moſt of all, if inſtead of a penetrable medium there were an unyielding obſtacle, to receive the *action* of the whole *activity* of the body.

K When in the former part of this work it was ſaid, that motion implied action (P 48), we were not prepared to make the diſtinction, here neceſſary to be attended to, between activity and action. We ſpoke of action there in its general ſenſe as oppoſed to inertia; motion could not be admitted to depend on inertia, but was proved to be preſerved by an active cauſe, and we did not ſcruple to call it an action, till now that our further progreſs leads us to more accurate diſcriminations. This will be the caſe with other terms which relate to the main buſineſs of our inquiries. We muſt begin with uſing them in the accuſtomed ſenſe; but as the ſubject opens and becomes more clear, new diſtinctions and new definitions will be neceſſary. The doctrine that a body perſevered in an uniform motion in a right line by its inactivity, was combated and ſhown to be an error, and the whole motion, beginning, middle, and end, proved to be one continued action; but now, that we diſtinguiſh between action and activity, it will be more juſt to ſay, that the whole continued motion is one continued activity, and that action exiſts only when the body is acquiring motion by the communication of the ACTIVE SUBSTANCE (L 115), or when the motion is diminiſhing or ceaſing by the impulſe of the body on obſtacles, which obſtacles themſelves acquire activity by that impulſe.

From what has been ſaid we may learn that action is proportionable always to the activity, and, if I may ſo ſay, the paſſivity, compounded together; for the activity cannot act without ſomething on which to act, that is to unite itſelf to (N 116), nor can there be any action from the patient alone without ſomething active. The L ſame activity may, we have ſeen, have any quantity of action, from nothing to its whole quantity (I 124), or till the whole ACTIVE SUBSTANCE is united with the patient which receives its action.

M BODIES BY IMPULSE ON OTHERS LOSE THEIR ACTIVITY IN PROPORTION TO THE IMPULSE.

This is matter of obſervation. Bodies which move in rare *mediums* move for a longer time, becauſe they impel leſs; and if they meet any obſtacle capable of receiving the whole activity at once, in the impulſe of the body, the body ſuddenly loſes its whole activity and comes to reſt.

N Hence, a body by acting loſes the activity which enabled it to act; for only the impulſe of the body is its action; its motion is not its action but its activity; by impulſe it loſes its motion, that is, by acting it loſes its activity.

O BODIES WHICH SUFFER IMPULSE ACQUIRE ACTIVITY IN PROPORTION TO THE IMPULSE.

This alſo is matter of obſervation.

P The ACCESSORY ACTIVITIES of bodies (G 114) as explained to be thoſe which are not proper to bodies, but derived, have been ſhowed to be induced upon them by the acceſſion and union of the ACTIVE SUBSTANCE with them (H 115).

When any ACCESSORY ACTIVITY in a body Q
ceaſes, it has either received a new and contrary activity, or is deprived of its acceſſory ACTIVE SUBSTANCE (S 118).

IN IMPULSE THE ACTIVE SUBSTANCE PASSES R
OUT OF THE IMPELLING BODY INTO THE BODY IMPELLED.

Bodies in motion are active (P 48), and activity conſiſts in the preſence of the ACTIVE SUBSTANCE (I 59), and by impulſe bodies loſe their activity (M 126), therefore they loſe their ACTIVE SUBSTANCE, and the loſs is proportional to the impulſe (M 126). Bodies impelled acquire activity (O 126), therefore acquire ACTIVE SUBSTANCE, and they acquire proportional to the impulſe (O 126); now the ACTIVE SUBSTANCE loſt by the impelling body ought to be concluded to be that found in the other, becauſe there is no other receptacle than the impelled body to which the ſubſtance parted from can be traced, nor any other ſource than the active body from whence that which is ſound can be derived; therefore in impulſe the ACTIVE SUBSTANCE ought to be concluded to paſs from the impelling body into the body impelled.

S THE CONTINUED MOTION OF A BODY DEPENDS UPON THE CONTINUANCE OF THE ACTIVE SUBSTANCE WITHIN THE BODY.

For the motion of the body depends on its activity, and its activity depends on its union with the ACTIVE SUBSTANCE; ſo long therefore as the body continues moving, it continues active, and retains its ACTIVE SUBSTANCE.

T THE MOTION OF A BODY IS PRODUCED BY THE MOTION OF THE ACTIVE SUBSTANCE IN UNION WITH THE BODY.

It being evident that ſince the ACTIVE SUBSTANCE itſelf does always move, whatever it is united to will be moved along with it, if no obſtacle prevent.

Otherwiſe, ſince the ACTIVE SUBSTANCE is itſelf active only by its motion (o 107), it is only by its motion that it can render bodies active, or produce motion in them when united with them.

U ACTIVITY IS, IN IMPULSE, COMMUNICATED FROM THE AGENT TO THE PATIENT BY THE FLOWING OF THE ACTIVE SUBSTANCE OUT OF THE AGENT INTO THE PATIENT.

It has been proved that in impulſe the ACTIVE SUBSTANCE does actually paſs from the impelling to the impelled body (R 127); conſequently activity is communicated by this means.

For the communication of an effect involves, by the ſecond rule, the communication of the cauſe, otherwiſe the cauſe could not be preſent with the effect.

The flowing of the ACTIVE SUBSTANCE is a ſufficient cauſe of the communication of activity, and no other rational cauſe can be aſſigned; this, therefore, ought to be conſidered as true, as well as ſufficient.

In mere motion, the body moved is the patient, and the ACTIVE SUBSTANCE the agent. In impulſe, the body in motion may be conſidered as an agent, as it is made active by its ACTIVE SUBSTANCE.

Impulſe may happen when the active body or agent meets with another body, either at reſt, or moving in ſome other direction than the direction of its own action, or moving in the ſame direction with its own, but with leſs velocity. But for greater ſimplicity, we will conſider the impelled body, or patient, as always at reſt, and in this light, as a patient, it ought to be conſidered; for if it be moving in a direction contrary to the agent, itſelf becomes alſo an agent. If moving in the ſame direction with leſs velocity, the impulſe is the ſame as if the patient were at reſt, and the agent were only moving with its exceſs or difference of velocity.

Z Therefore the patient as ſuch, is to be conſidered as always at reſt, and as inactive; conſequently, as having no tendency to motion.

A AN INACTIVE BODY BEING IN A PART TO WHICH AN ACTIVE BODY TENDS TO MOVE WILL BE AN OBSTACLE TO THE MOTION OF THE ACTIVE BODY.

For in order that the active body ſhould move, either the inactive one muſt alſo move, ſo as not to impede it, or the active body muſt paſs through the inactive one; but the inactive body cannot move, becauſe it is inactive; and the active body cannot paſs through it, becauſe of the coheſion of the parts of the inactive maſs; therefore, until one of thoſe impediments are removed, it is impoſſible the active body ſhould move.

B THE ACTIVE SUBSTANCE UNITED WITH AN ACTIVE BODY OPPOSED BY AN OBSTACLE WILL FLOW OUT OF THE ACTIVE BODY INTO THE OBSTACLE.

The obſtacle, by its coheſion, reſiſts to the active body only (c 130), but does not reſiſt the admiſſion of the ACTIVE SUBSTANCE (M 116); the obſtacle, therefore, impedes the body only, but not the ACTIVE SUBSTANCE; and the ACTIVE SUBSTANCE continuing to move, leaves behind it the body to which it belonged, and, finding the obſtacle in its way, readily enters it.

C It has been already proved by inference from the effects, that the ACTIVE SUBSTANCE does paſs out of an impelling body into one impelled. Here it is proved from the nature of the ACTIVE SUBSTANCE, as motive and unſolid, and the nature of matter as quieſcent and reſiſting penetration by matter, that this muſt neceſſarily happen.

D THE OBSTACLE BECOMES ACTIVE BY THIS ACCESSION TO IT OF THE ACTIVE SUBSTANCE (H 115).

E WHEN A SUFFICIENT QUANTITY OF ACTIVITY IS THUS INDUCED IN THE OBSTACLE, IT WILL BE CAPABLE OF MOVING, SO AS NOT TO IMPEDE THE OTHER ACTIVE BODY, AND WILL BE NO LONGER AN OBSTACLE, UNLESS ITSELF BE ALSO IMPEDED BY ANOTHER OBSTACLE.

F WHILE THE ACTIVE SUBSTANCE IS FLOWING OUT OF THE ACTIVE BODY INTO THE OBSTACLE (D 130), THE ACTIVE BODY WILL PRESS ON OR IMPEL THE OBSTACLE.

While the ACTIVE SUBSTANCE is yet within the body, although flowing through it, it does not ceaſe to impart to the body its own nature, nor can the body ceaſe to be active becauſe not yet deprived of the ACTIVE SUBSTANCE; therefore during its paſſing out of the body, ſuch portion of the ACTIVE SUBSTANCE as is yet within, is urging and diſpoſing the body to move, in like manner as if the ACTIVE SUBSTANCE were CONTINUING in the body (S 128), and the body being thus urged to move, but impeded from moving, preſſes or impels the obſtacle.

G We ſee here an obvious explanation of impulſe; it conſiſts in the flowing of the motive ſubſtance from a ſource into a receptacle. In order to this, an *obſtacle* muſt impede the *active body*; for otherwiſe the ACTIVE SUBSTANCE will carry the body along with it, and not quit it. The *obſtacle* muſt receive this SUBSTANCE as it eſcapes from the *active body*, becauſe it is in its path; and the ACTIVE SUBSTANCE, while quitting its firſt body, ſtill urges it to move, and cauſes it to impel.

Although the exiſtence of the ACTIVE SUBSTANCE had not been eſtabliſhed on any previous grounds, the phenomenon of communication of motion by impulſe does alone afford a philoſophical proof of its reality. H

Becauſe if a fact admits of only one explanation, and that be intelligible, analogous to the fact, agreeable to the common order of things, and complete, that explanation ought to be conſidered as true, although it may be founded in hypotheſis. I

For it being the end of philoſophy to explain facts, it would not be conſiſtent with that end to reject an explanation, the only one which can be given, and one intelligible, analogous to the fact, agreeable to the common order of things, and complete, becauſe it reſted on hypotheſis; ſince, rejecting this, we muſt remain in ignorance, and we ought to prefer imperfect information to abſolute ignorance. But further, ſince no other explanation can be given, we ought to conſider the hypotheſis as proved, and no longer hypothetical; ſince where there is but one natural means of producing an effect, nature muſt operate by that means; where we find but a ſingle road we are certain we cannot err in our choice. K

L Now if we reject the doctrine of communication of ſome motive virtue, between bodies in impulſe, we can no otherwiſe explain the parts of the phenomenon, nor the final effect: for example, how the agent has its motion diminiſhed; how the patient has motion given to it; why the quantities of theſe motions are equal; why the changes happen at the ſame time; and why they depend on the connection of the two bodies.

M But when motion is loſt out of one body, and a ſimilar motion is found in another body ſo connected with the former as to allow of communication, and the quantities loſt and found are equal, and the appearance in one body anſwers in time to the diſappearance in the other, all of which may be ſaid of the motion in impulſe; the ſuppoſition of communication of a motive virtue is intelligible, analogous to the appearances, agreeable to common obſervation, affords a complete explanation, and ought therefore to be conſidered as true: but this explanation being admitted, the exiſtence of the ACTIVE SUBSTANCE muſt alſo be admitted on this ground alone; for that muſt neceſſarily be A SUBSTANCE which can paſs, or be communicated from one body to another.

N But if any ſhould refuſe to admit a new principle of ſuch importance unleſs it can be ſupported by facts; it is replied, that, in this caſe, facts cannot be adduced in direct proof; ought not to be expected; and that the rational evidence before us, is already ſtronger than any which could ariſe from ſenſible appearances alone, were ſuch to be produced, without the ſame rational demonſtration. So great in the preſent day is the predilection for facts, that men ſeem to conſider truth in no other light than as tangible, viſible, or manifeſt to ſome ſenſe. If we could in impulſe, diſcern ſomething paſſing from one body to the other, this appearance, without the rational evidence adduced, would not be a ſufficient ground on which to eſtabliſh a principle, like that of the ACTIVE SUBSTANCE. We might ſuſpect, in this caſe, an illuſion of viſion; and even, if we could not doubt of the fact, ſtill, we ſhould want aſſurance that this viſible fluent was itſelf the active principle of impulſe; or rather we ſhould be aſſured that it could not be; for wereit viſibleit would be material, if material, inactive (Y 120), and incapable of being a principle and ſource of activity. Facts are the ſenſible baſis from which we infer our principles, the truth of which appears in the ſatisfactory explanation of facts which they afford; but ſo far is it from being poſſible, that any experiment ſhould diſcover this agent, the ACTIVE SUBSTANCE to the ſenſes, that the being diſcoverable by the ſenſes would be itſelf a proof that the thing ſo diſcovered was not this agent in natural effects.

O Hitherto we have ſpoken of impulſe in the general only, we are yet to conſider it as it is diſtinguiſhable into its two forms of preſſure and percuſſion (E 123).

P Preſſure is the impulſe that an active body exerts upon another, with which it is in contact. Pulling may alſo come under the head of preſſure, as a modification of it.

Q Percuſſion is the impulſe that an active body exerts on another at the time of coming in contact with it.

R Or, they may be thus diſtinguiſhed: Preſſure is the impulſe of a body having more activity on another having leſs, both having equal velocities in the ſame direction, or both being at reſt. Percuſſion is the impulſe of a body having more velocity on another having leſs in the ſame direction. A man *preſſes* a body that he puſhes before him, both moving with equal velocities; but the man having more activity, or tending to move faſter than the body. A ſtone projected *percuſſes* or ſtrikes againſt any fixed body, the ſtone having the greater velocity, before colliſion.

It has been ſhown that impulſe in the general, S
whether of preſſure or percuſſion, produces a flowing of the ACTIVE SUBSTANCE out of the agent into the patient, ſo long as the impulſe continues (R 127).

This circumſtance being common to both T
modes of impulſe, it remains to inveſtigate in what peculiarities of the flow conſiſt the difference between the two modes of preſſure and percuſſion.

Theſe we muſt ſeek by attending to the U
differences in the facts themſelves.

Preſſure is an impulſe, which may be con- X
tinued indefinitely, of an active body on another with which it is in contact (P 136); again, in preſſure, the velocities of agent and patient are equal, that is, both may be conſidered as at reſt (136).

Percuſſion is an impulſe, which cannot be Y
continued, of a body at the time of coming in contact with another: alſo, in percuſſion, the

agent has more velocity, before colliſion, than the patient; therefore, percuſſion is to be conſidered as the act of a body in motion, and prepared for its action, by its motion (R 136).

Z Since preſſure is an impulſe that may be continued, the flowing of the ACTIVE SUBSTANCE is continued, during the preſſure.

A Since in percuſſion the impulſe is tranſitory, the flowing of the ACTIVE SUBSTANCE is alſo of ſhort duration.

B It follows from hence, that if the ſame quantity of motion be imparted, by a preſſure of ſome continuance, and by a percuſſion, ſince, in either caſe, the ſame quantity of ACTIVE SUBSTANCE will be tranſmitted or flow from the agent to the patient, and in the caſe of percuſſion it will flow in a ſhorter time; the flow muſt be more rapid and violent in percuſſion than in preſſure.

C Since, during any preſſure, the ACTIVE SUBSTANCE continually flows out of the preſſing body, either that body itſelf muſt be the ſource of this flow, or the body muſt be the channel through which the ACTIVE SUBSTANCE flows from ſome other ſource.

But, it appears from obſervation, that a body does not preſs, unleſs it be ſubjected to ſome of the circumſtances or origins of ACCESSORY ACTIVITY (I 115); either the regular action of gravity, or ſome accidental action, as a man's hand, a bended ſpring, &c. D

Hence it appears, that a body preſſes by means of an ACCESSORY ACTIVE SUBSTANCE (I 115), entering from without and paſſing through the body, and cauſing it to preſs as it is flowing through it, in the manner explained (F 132). E

And this alſo appears, becauſe the preſſure of a body is in ſome caſes, as in gravity perpetual. F

For if the ACTIVE SUBSTANCE originated in the preſſing body, its quantity muſt have ſome limits, and, after a certain time, greater or leſs, the ACTIVE SUBSTANCE in any body continuing to flow out would be exhauſted; and before it was altogether exhauſted, it would be continually diminiſhed, and the preſſure would continually decreaſe till it finally ceaſed; but theſe do not agree with the facts. G

In other caſes the time of preſſure depends on external circumſtances, and not at all on any thing in the nature or magnitude of the body; H as when a man, or a ſpring, cauſes a body to preſs; therefore, the bodies, in no caſe, preſs by an inherent activity, but by a ſuperadded one.

I A percuſſing body, on the contrary, is itſelf the ſource of the ACTIVE SUBSTANCE, which flows out of it on colliſion.

K For a percuſſing body is in motion previous to percuſſion, and the previous ſtate of motion is neceſſary to fit the body for percuſſion (Y 137).

L Now, a body during motion, is not neceſſarily ſubjected to any of the origins or circumſtances of acceſſory activity (A, &c. 108); a projectile, for example, has at the time it received the impulſe which made it a projectile, received the ACTIVE SUBSTANCE from ſome origin, as elaſticity, or animal volition; but the body, flying from this ſource, has no longer any connection with it, nor is ſubject to its influence. The ſtone impelled by a man's arm, has no longer any ſubjection to the arm when it is paſſing through the air; it therefore continues to move by a retained and inherent activity.

M Again, in *preſſure*, the ſmaller of two bodies, both at reſt, may preſs more, becauſe the preſſure depend not on the bodies; but if two bodies are *moving* with equal velocities, the greateſt maſs will always have a proportionally greater capacity of percuſſion; therefore, the percuſſion is dependent on the maſs, and is performed by an inherent activity, imparted to the body, when it was put in motion.

It has alſo been ſhown that the motion of a N
body depends upon the continuance of the ACTIVE SUBSTANCE within the body (s 128).

We may diſtinguiſh the ſtates of the ACTIVE O
SUBSTANCE, as it is in a moving body, and in an impelling body, into the STATE OF RETENTION and the FLOWING STATE. During motion, the ACTIVE SUBSTANCE continues in the body, and this may be called its RETAINED STATE; but it is to be obſerved, that by retained, it is not meant that the ACTIVE SUBSTANCE is held or confined by the body, but only that it remains within it. In impulſe, the ACTIVE SUBSTANCE being paſſing or flowing out of the impelling body, this may be called the FLOWING STATE of the ACTIVE SUBSTANCE. Here again it is to be obſerved, that the term flowing is employed only to ſignify the ſtate of the ACTIVE SUBSTANCE relative to the body; for in both ſtates the ACTIVE SUBSTANCE itſelf is moving, and may be ſaid always to flow; but in the ſtate

of retention, the containing body moves with it; in the flowing ſtate the ACTIVE SUBSTANCE paſſes out of the body, or flows through it.

P A body in motion has received a certain quantity of ACCESSORY ACTIVE SUBSTANCE from the agent which gave it motion; and when it has gotten out of the reach of receiving any increaſe, this quantity already poſſeſſed continues in the body, by its own motion moving the body (T 128), but remaining at reſt in and relative to the body, as the rowers of a veſſel, which give motion to the veſſel, move together with it, but are relatively to the parts of the veſſel at reſt.

Q The moving body is thus poſſeſſed, in itſelf, of a limited quantity of ACCESSORY ACTIVE SUBSTANCE, which, as it has received, it can part with again; and as it moves by the preſence of this ſubſtance, ſo when it no longer poſſeſſes it, it ceaſes to move.

R Therefore, when an obſtacle is oppoſed to a body in motion, if it be of ſuch magnitude as to receive no ſenſible velocity from the blow, the obſtacle will rob the moving body of its ACTIVE SUBSTANCE; for the obſtacle obſtructs the paſſage of the body, but the ACTIVE SUBSTANCE freely pervading all bodies paſſes on, out of the body, now at reſt, which it before moved, and enters the obſtacle.

Hence percuſſion is tranſitory, becauſe there is no continued ſupply of the ACTIVE SUBSTANCE, but as ſoon as all that was in the projectile has flowed out of it, there is no longer any flow, nor does the impulſe continue any longer. S

A preſſing body at reſt continually ſuffers the ACTIVE SUBSTANCE to flow through, and thus can never accumulate a quantity, and never increaſes its own activity, ſince it parts with its ACTIVE SUBSTANCE as faſt as it receives it. T

But a body, when it acquires motion, has accumulated a certain quantity of ACTIVE SUBSTANCE, which it retains. For in order to its acquiring motion, there is required the abſence of ſuch obſtacles as might impede the body; that is, as might ſerve to receive and rob it of its ACTIVE SUBSTANCE. Two circumſtances therefore, connected with each other, go to the motion. The abſence of an obſtacle, and the conſequent retention of the ACTIVE SUBSTANCE in the body; from theſe the motion of the body neceſſarily follows (T 128). U

Therefore,

X Therefore, the impulſe of percuſſion is the impulſe of a body, which, having previouſly been in motion, has obtained an accumulation of ACTIVE SUBSTANCE, continuing or retained within the body.

Y At the time of the colliſion, this accumulated quantity of ACTIVE SUBSTANCE then begins to become a flowing ſubſtance in the impinging body, becauſe then, and not before, it begins to eſcape from that body into the obſtacle.

Z Theſe then are the ſeveral circumſtances of the flow of the ACTIVE SUBSTANCE, on which the different facts which characterize preſſure and percuſſion depend, and which ſerve to explain thoſe facts.

A Percuſſion is, when the ACTIVE SUBSTANCE, from a ſtate of retention, changes to the flowing ſtate, which is, when a body in motion firſt meets an obſtacle, and the motion is changing to an impulſe (Y 144).

B Preſſure, is when the change from the ſtate of retention to the flowing ſtate, or from motion to impulſe, is completed, and the flowing ſtate actually exiſts.

The force or efficacy of percuſſion or preſſure C to produce any effect, conſiſts not in any ſtate or diſpoſition of the body percuſſing or preſſing, but in the paſſing of the ACTIVE SUBSTANCE out of this body into the patient, and imparting its activity to the parts, or the whole of theſe bodies, wherever it pervades.

Since percuſſion conſiſts only in the change of D the condition of the ACTIVE SUBSTANCE from its retained to its flowing ſtate, preſſure muſt ſucceed to and terminate every percuſſion; for when the ACTIVE SUBSTANCE, in an impinging projectile, has commenced its flowing ſtate, it then goes on actually to flow out of the projectile; and during this actual flow, the body is preſſing, the percuſſion being over: but projectiles preſs for a very ſhort and almoſt inſenſible time after they ſtrike, becauſe they are ſoon deprived of their whole quantity of acceſſory ACTIVE SUBSTANCE (R 142).

Bodies falling by their gravity, afford a good E illuſtration of both theſe ſtates. While a body is falling it continues expoſed to the influence of gravity, that is, it is acquiring ACTIVE SUBSTANCE, but, meeting with no obſtacle, the air not being here conſidered, it parts with none, or retains all the ACTIVE SUBSTANCE it acquires, which therefore accumulates continually, and increaſes the celerity of the body till it meets with an obſtacle or ſupport, when the body, by a percuſſion, ſuddenly parts with this accumulated quantity of ACTIVE SUBSTANCE; after which it continues to preſs downwards, not with the ſame vehemence with which it is impinged by means of its accumulated activity, but with the equable activity of the ACTIVE SUBSTANCE of gravity continually paſſing, through the body, to the earth.

F This ſubject of impulſe will be further proſecuted in another place, and the various facts of preſſure and percuſſion, be more largely explained. Thus far, the general principle elucidates the general facts: all impulſe is, to appearance, the action of body at reſt: thus, in preſſure, the body is all along at reſt; in percuſſion, the action begins when the motion begins to be impeded; but action can never be conceived as originating in quieſcence, or as allied to reſt; and hence the obſcurity of all theory, in regard to impulſe, when body alone is conſidered therein: but a knowledge of the unſeen agent that pervades bodies and continually moves through their ſubſtance while the bodies are at reſt, reconciles facts to reaſon, and reflects a light upon the inquiry, which could never have been derived from experiment.

CHAP. VI.

Of the Production of Matter from its immaterial Elements.

A THE origin of that activity in bodies, termed acceſſory (G 114), although not innate, is no longer obſcure, ſince there appears to be a ſubſtance in nature eſſentially active, uniting with filling, and freely pervading bodies, and thus inducing the acceſſory activities.

B The varieties alſo of activities in bodies, as diſtinguiſhed into motion and impulſe (B 122), become obvious and familiar, as referable to the preſence of the ſame cauſe, the ACTIVE SUBSTANCE, under different given circumſtances. In the conceiving of theſe things there ariſes no difficulty; the exiſtence of the ACTIVE SUBSTANCE itſelf being once comprehended, its effects in union with body, to render it active, and make it either move or impel, follow, by a neceſſary conſequence, from the conditions ſuppoſed.

C But it may ſeem more difficult to comprehend that matter conſiſts of immaterial elements; and that an unſolid and active being ſhould, by any modifications whatever, become a ſolid and inactive maſs. This is a transformation that may, to many, appear not only problematical and difficult to conceive, but wholly impoſſible, and implying contradictions, abſolutely and for ever irreconcilable.

D But theſe difficulties, which appear to impede a tranſlation of the ſame ſubſtance from immaterial to material, and reciprocally from material to immaterial, ariſe only from erroneous preconceived conceptions of the nature of matter, and the way in which it differs from immaterial exiſtence; and when theſe errors are corrected, the difficulty is removed.

E If the nature of matter be a pure and eſſential *inertia*, an abſolute privation of active qualities; if it be, in every view, both as a whole, and in its parts, in itſelf, and in its elements inactive; without doubt it will follow that a ſubſtance immaterial and eſſentially active can never by any modification become matter; ſuch ſubſtance, and matter, can only be conceived of, as beings wholly unrelated; without any common property, without any intelligible means of union, of attachment, of mutual influence, ſeparated to our conceptions by an immeaſurable diſtance; and their actual or ſuppoſed union in man's nature, as a perpetual miracle.

F But the nature of matter conceived, as it is, at once active and inert, gives it a relation to immaterial natures, by which the connection, transformation, and union of the two, may alſo readily be conceived.

G When we no longer conſider the ſolidity of matter, as an inactive repletion of ſpace with an unknown ſubſtratum, ſubſtance, or eſſence; with parts *held* together, in a manner incomprehenſible, without *action*; hard, impenetrable, and reſiſting power, but itſelf without power; when in the room of theſe incongruous ideas, and this contradictory language we ſubſtitute an idea of matter as being compoſed of active elements, by their own activity forming attachments, exiſting in union, and reſiſting ſeparation; and by the reciprocal and equal contrariety of theſe activities, every union, thus formed, remaining in an equilibrium, and becoming inactive. This view of matter affords us an eaſy ſolution of a problem, which, upon the other, would have been for ever, as hitherto, inexplicable.

Conſidering

H Conſidering it therefore, as a truth already demonſtrated, that the ACTIVE SUBSTANCE is the elementary principle, eſſence, or ſubſtratum of matter; ſince theſe elements, and theſe alone reſult from a decompoſition, actual or ideal of matter; it is here to be inquired the manner how theſe elements form their compound, and by what modification the ACTIVE SUBSTANCE, retaining its own nature and eſſential properties, continuing immaterial, unſolid, and active, puts on at the ſame time the form of matter, and becomes material, ſolid, and inert.

I I am well aware that not only the common prejudices of mankind, but even thoſe of philoſophers, of almoſt every deſcription, will militate ſtrongly againſt the very principle of the inveſtigation here propoſed.

K The production of matter, out of another ſpecies of being, not material, is, as far as I know, a problem in philoſophy altogether new, and which, ſo far from having been already ſolved, has never yet been propoſed.

L In all men's reſearches, analyſes, and diviſions on the ſubject of bodies, matter has been conſidered as the firſt genus. Neither chemiſtry by its experimental, nor metaphyſics by its rational inveſtigations, have ever propoſed any higher object than to diſcover thoſe moſt ſimple parts of matter, which are the baſis of its compound varieties. Nor was it ever conceived that theſe ſimple parts, or that the general idea of matter itſelf, abſtracted from its various modifications and ſpecies, was yet a compound derivative being, reſolvable into a more ſimple eſſence, and to be traced to a more remote origin in the ſeries of natural cauſes and effects.

But if any one examines the grounds on which M he concludes matter to be an original being, underived from any prior exiſtence (except the FIRST EFFICIENT CAUSE); and wherein is the impoſſibility of conceiving matter to be formed, by natural means, out of an immaterial ſubſtance, he will probably find theſe notions to have no other foundation than prejudice; a prejudice indeed ſo early implanted, and ſo deeply rooted, as to influence the mind like the cleareſt demonſtration or moſt evident truth.

Almoſt all philoſophers have agreed that there N is between material and immaterial beings, ſo wide a chaſm, ſo perfect a diſcontinuity, ſo total a deprivation of connection, ſimilitude or common properties, that no chain of reaſoning could ever lead the mind from one to the other, or enable it to conceive of any relation or mutual intercourſe between them. Hence, although moſt ſpecies of bodies underwent an analyſis, matter itſelf was never conceived of as a ſubject of decompoſition, or as a compound conſiſting of principles more ſimple than itſelf.

o When any compound is reſolved into its component principles, thoſe principles have ſeparately each a different nature from the compound which they form when united, and require each to be marked by a different name.

p We muſt be careful here to diſcriminate between the diviſion of wholes into parts, and the ſeparation of compounds into principles; a half, fourth, tenth, or any fractional part, has the ſame nature with the whole and differs only in quantity; for this ſort of diviſion has no reſpect to the qualities of things, but to their relative quantities only. But when a certain nature or quality belonging to any body, is produced from the union of ſeveral other bodies, each of different qualities, here ariſe a ground of diviſion of a different ſort, which has no regard to quantities, wholes, or parts, but merely to the qualities of things; and when a ſingle ſubſtance reſults from an union of two or more, the ſeparation of thoſe things, thus united, reproduces the original and ſeparate ſubſtances, while it deſtroys the compound, which exiſted only in their union. Wine, *e. gr.* is a compound liquor, produced from an union of ſeveral other things, neither of which, of themſelves, are wine. On diſtillation, a pure ſpirit, water, and earth, are found to have been united in the compound wine. The ſeparation of theſe deſtroys the wine, and gives riſe to the diſtinct exiſtence of the ſpirit, earth, and water. The ſeparation of theſe is altogether different from a diviſion of the wine, as it reſpects quantity; for we may divide a portion of wine indefinitely into ſmaller quantities, while each divided portion ſhall ſtill be wine, becauſe it retains in union the three principles, water, ſpirit, and earth.

We may, therefore, to preſerve theſe different Q ſorts of diviſions diſtinct, call the diviſion that has reſpect merely to quantity, a ſeparation of parts; the other, which has reſpect to qualities, a ſeparation of principles or elements; thoſe more ſimple things, which by union form a more compound, being uſually denominated the principles or elements of the compound.

The latter of theſe methods of diviſion anſwers R alſo to the terms analyſis, reſolution, or decompoſition. And this, chemiſtry practically applies to particular genera or ſpecies of bodies, as minerals, vegetables, ſpirit, oil, ſalts, &c. to diſcover the more ſimple principles of theſe compounds, and again to thoſe principles, as themſelves compounds, to arrive at their principles. But to matter in the general, as a ſolid extended ſubſtance, not diſtinguiſhed into this or that particular kind, this ſort of anylyſis has never, that I know of, been applied. Matter has been conceived as being capable of a diviſion only into *parts* continually leſs and leſs, each part ſtill being matter, but not of a decompoſition into *principles* of a different nature from matter.

S If we conſider matter in its general nature, as a compound formed of more ſimple elements (H 150), theſe elements muſt differ from matter as the elements of wine, ſpirit, earth, and water, differ from wine. Theſe have not the qualities of wine, and therefore do not anſwer to the definition of the term wine; ſo in like manner the ſeparate elements of matter, if there be any ſuch, cannot anſwer to the definition of matter; they cannot ſeparately have the properties of matter, becauſe theſe properties ariſe from their union only: theſe elements therefore cannot be matter, and, not being matter, muſt neceſſarily be immaterial.

Since therefore an analyſis of matter muſt needs have led to this concluſion, that matter was compoſed of elements or principles, which were immaterial, and this concluſion again would neceſſarily have eſtabliſhed a relation between material and immaterial being, directly contrary to the powerful prejudices entertained, that this relation was utterly impoſſible, this preconceived error ſtood in the way, as an effectual barrier againſt ſuch an inveſtigation, and precluded in the very outſet, every advance in this path, towards any further diſcovery of truth. T

It would not perhaps be difficult to trace the origin of this prejudice, in certain religious hypotheſes. Pious men, being deſirous to exalt the ſpiritual nature of the human ſoul, and philoſophy having taught them that matter was inert, dead, lumpiſh, periſhable; they thought they could no way dignify the mind ſo much as by denying to it every property belonging to body, and diſclaiming all relation to it. When, however, philoſophy ſhall have more juſtly developed the nature of corporeal being, and aſſerted its higher dignity, it may no longer be thought unworthy or incapable of a relation to mind, and immaterial beings, and of an union with them. U x It is, however, not a little remarkable that this opinion of the diſtinct and irreconcilable natures of body and mind could ſo long have ſubſiſted, and ſo generally have obtained, in contradiction to the moſt obvious fact that ever preſented itſelf as a guide to truth, the actual and intimate union of our own minds and bodies; and that men ſhould, contrary to all juſt methods of inveſtigation, deem a perpetual occurrence in the uniform order of nature, a conſtant miracle and violation of nature's laws, becauſe not reconcilable to their hypotheſes, when they ought rather, laying aſide hypotheſes, to have conſidered this very fact as part of the general ſyſtem from which the laws of nature were to be learned.

Y This analyſis of matter, has been done in the firſt part of this work, and the reſult has been, as it muſt be in every reſolution of a compound into its elements, that the elements are of a different nature from the compound; and conſequently that the elements of matter are not of the nature of matter, but immaterial.

z By immaterial, I mean here, and wherever I uſe the term, only to exclude from a being the properties which conſtitute matter, but not to aſſert any poſitive qualities of that being;

there may be as great diverſities, for aught we know, among immaterial ſubſtances, as among material ones, although we have not names or ideas of many of thoſe diverſities.

In conſidering matter as porous, we concluded that there muſt be an ultimatum of poroſity, or certain parts void of pore, which muſt be conſidered as primary parts or atoms, whoſe imperfect continuity forms the primary and ſmalleſt pores. A

It is generally agreed that all ſenſible maſſes of matter are porous, that is, are compoſed of a number of the imporous parts (A 157), each individually, too ſmall to excite any ſenſation, adhering at certain points only, and at other points diſcontinuous. B

There are, therefore, two diſtinct facts in every ſenſible maſs of matter, the production of which we ſhall examine ſeparately, in the order of their occurrence; *firſt*, the formation of a primary and imporous atom, or the moſt ſimple portion of matter; *ſecondly*, the union of theſe atoms, ſo as to form larger, and at length ſenſible maſſes: this latter effect is commonly called coheſion, and this word by ſome may be thought to explain ſomething of the fact; but to ſay that the C the parts of bodies ſtick together by coheſion is only to inform us that the parts of bodies ſtick together by ſticking together.

D It is proper here, previouſly to entering upon the inquiry how the primary atoms are formed, to recall the reader's attention to what has been ſaid reſpecting their nature, and in what reſpects the atoms which are here conſidered as the moſt ſimple parts of bodies, differ from thoſe which are exhibited to our imagination in the modern philoſophy.

E The atoms of the modern philoſophy are conceived to have an extenſion, never preciſely aſſigned, but in ſome finite relation leſs than the leaſt viſible magnitude.

F Theſe atoms are ſuppoſed to have the greateſt poſſible ſolidity ; and this ſolidity is thought to conſiſt in a fulneſs of the extenſion of the atom, in ſuch ſort, that being full, that ſame extenſion cannot poſſibly receive more ; but if we aſk, of what the extenſion of the atom is full, that is, in other words, what makes the atom ſolid and makes it matter; this the modern philoſophy does not teach. It is ſaid to be very hard, ſo hard as never to be broken by any force ; but what makes it hard, or prevents its breaking is not determined. It is ſaid to be inactive, and this inactivity is ſaid to conſiſt in a tendency to perſevere in either ſtate, of reſt, or uniform rectilineal motion, which it at any time may happen to be in; that is, it may be either a *quieſcent* inactivity, or a MOTIVE inactivity, as accident determines; and this inactivity, thus explained, is ſuppoſed to belong to the whole atom collectively, and to every part diſtinctly, if parts are diſtinguiſhed in it.

This idea of a fulneſs which reſiſts, becauſe, G being full, the extenſion ſo filled can admit of no increaſe of ſubſtance, appears to be founded upon an erroneous notion of fulneſs; the fulneſs of any extenſion does not imply the excluſion of new ſubſtance from entering the ſame place already full. For fulneſs does not imply reſiſtence, becauſe reſiſtence is action, but fulneſs is not action. If a place be full, no part of the place is without the filling ſubſtance, or, the filling ſubſtance is preſent in every part of a place which it fills. But a ſubſtance which *fills* a given extenſion may be more or leſs denſe; for if a ſubſtance can exiſt leſs denſe than another ſubſtance, there can be no reaſon why this ſubſtance, of leſs denſity, ſhould not be preſent *in every part* of a given extenſion; but if preſent in every part, there is no void or interſtice, and the extenſion is *filled* with the leſs denſe ſubſtance. Then ſince, alſo, a more denſe ſubſtance may exiſt, this may alſo fill an equal extenſion, and the given extenſion filled with a ſubſtance more denſe, contains more, than when filled with a leſs denſe ſubſtance; for although in both inſtances every part of each extenſion has the ſubſtance preſent, yet every equal part has *leſs* of the leſs denſe ſubſtance, conſequently, that whole extenſion contains *leſs*, which contains the leſs denſe ſubſtance.

H Hence an extenſion *full* of a ſubſtance, may receive *more*, by the addition increaſing the denſity of the filling ſubſtance.

I But that we may ſee how errors, in like manner with truths, ſerve mutually to each other's ſupport, we muſt obſerve that the term *denſity* has been perverted from its ſimple and familiar acceptation, and adapted to the purpoſes of a theory, at the expence of reaſon and nature. Denſity, in its common and juſt ſignification, imports that relation which ariſes from a variation of the quantity of a ſubſtance in a given magnitude; thus if A, in a cubic inch, contains twice the quantity of B in the ſame magnitude, A has double the denſity of B; but in the uſage of the modern philoſophy, denſity is made to ſignify the greater or leſs poroſity of a body, and is in fine not at all different from poroſity. But the better to diſguiſe this fallacy, the language employed on this ſubject avails itſelf of the imperfection of our ſenſes, and ſubſtitutes apparent and falſe magnitude, for actual and true. The *true* meaſure of a fabric, or a machine, is the extent of its boundaries, becauſe the ſpaces within ariſe from thoſe diſtances of parts which properly belong to the object; but in meaſuring a body, the true magnitude is the pure extent of ſolid parts; for the internal vacuities, though they go to form a houſe, do not go to form matter; the ſolid parts only, and not the vacuities, are matter. The *common* meaſure of bodies comprehends a great quantity of inviſible pore, that is a great extent of vacuity, and is, therefore, though the *apparent*, a falſe meaſure of the extent of ſolid matter. To obtain the true magnitude of a maſs of matter, the extent of pore muſt be taken from the meaſure of the whole body, which is interſected by pores. Now if, of two bodies, A be more porous than B, philoſophers will ſay A is leſs denſe than B, becauſe in equal magnitudes of each; *ex. gr.* a cubic inch, A having more pore will have leſs matter; and to have leſs matter in an equal magnitude, is to be leſs denſe. But the truth is, that a cubic inch of A is not an equal magnitude of *matter* with a cubic inch of B; A having more void within its limits, has leſs *extent* of *matter* than B, and, therefore, ought to have leſs *quantity* to be equal in denſity. To obtain the true denſity, we muſt have the *quantity* of matter in a known *extent* of *pure ſolid*, and only as this quantity varies, denſities are different.

K Solidity, ſaid thus to conſiſt in a fulneſs of a thing unconceived; to have a hardneſs, the manner or cauſe of which is unknown; to have an inactivity participating of ſuch different natures, as motion and reſt, is a very obſcure idea; and we have ſhewn that this idea cannot be conformable to nature and fact, which preſent us obobviouſly with a very different one.

L We have ſhewn that ſolidity conſiſts in the preſence of a ſubſtance which excludes other ſubſtances from the place it occupies, not by *filling* the place, but by *acting* on that which it excludes; that this action conſtitutes reſiſtence, whether to being penetrated, or broken; that inactivity belongs only to any ſolid taken as a collective whole, but that all the parts, conſidered ſeparately, poſſeſs activity; that the inactivity of which we ſpeak, and which we reſtrict to the collective whole, but deny to the component parts of a ſolid, is not to be underſtood, like the inactivity of the modern philoſophy, as implying a *tendency* to perſevere in any preſent ſtate, of motion, or of reſt, but as a privation of all tendency, and a reſt conſequent of that privation, except inaſmuch as extraneous activities are ſuperinduced.

This being our idea of ſolidity, we conceive M of an atom as the leaſt ſolid whole, as the leaſt extenſion in which an active being is preſent under the conditions above deſcribed; that is, acting ſo as to exclude other beings, ſo as to preſerve its own figure and dimenſions from change, and by theſe two actions, preſerving itſelf ſolid, and hard, and ſo as by the equality of contrary actions to render the whole inactive.

An atom being conſidered as the leaſt ſolid N whole. If ſeveral atoms ſtick together by any means, they will make a larger maſs; but in this adheſion it is eaſy to conceive that without a peculiarity of figure and arrangement the atoms will not come in contact in all points mutually; ſo that in a maſs formed of ſeveral atoms there may be interſtices between them, in which interſtices there is nothing active, and which therefore may be eaſily penetrated, and theſe interſtices are called pores.

O Conformably to the foregoing ideas, the following definitions may now be given.

P SOLIDITY IS THE RESULT OF THOSE ACTIONS AMONG THE PARTS OF ANY WHOLE, WHEREBY THE UNITY OF THE WHOLE IS PRESERVED WITHIN ITSELF.

Several uncohering things may be united by an external band; this does not conſtitute theſe one ſolid, it may be one bundle; but if ſeveral things cohere and have a unity preſerved within themſelves, they become one ſolid.

Q AN ATOM IS THE LEAST AND MOST SIMPLE SOLID.

R Having thus brought into view the nature of an atom, in order to prepare us to inveſtigate its formation, and this nature appearing to conſiſt in activity and mutual actions of parts, we muſt now alſo recall attention to what has been ſhewn concerning activity and action.

S By *activity* is meant whatever has a diſpoſition to motion; by *inactivity* whatever has no diſpoſition to motion. Bodies have been ſhewn to be active in two forms, actual motion, and a meer tendency to motion, as in impulſe; but the ACTIVE SUBSTANCE has been ſhewn to have but one manner of activity, that is, by its motion, becauſe it is incapable of impulſe; and there can be no activity in a perfect reſt, void of any tendency to motion; therefore the ACTIVE SUBSTANCE moves as much as it is active.

Therefore we may ſpeak indifferently of the T *motion*, or of the *activity* of the ACTIVE SUBSTANCE, as ſignifying the ſame thing; for it is *active* inaſmuch as it *moves*, and it *moves* inaſmuch as it is active, and the quantity of the *motion* is proportional always to the *activity*; and again, converſely, the quantity of *activity* is proportional to the *motion*.

All the foregoing things relative to ſolidity, U atoms, and activity, being ſuppoſed, the following problem is required to be ſolved:

TO EXPLAIN THE FORMATION OF AN ATOM OUT OF THE IMMATERIAL ACTIVE SUBSTANCE. X

Whatever portion of the ACTIVE SUBSTANCE is given to form an atom, the followings things Y are neceſſary to be united in ſuch portion of ACTIVE SUBSTANCE.

Firſt,

Z First, it muſt in ſome reſpect continually move (O 106), for otherwiſe it would loſe its nature and ceaſe to be active.

A Secondly, it muſt alſo, in ſome other reſpect, be at reſt, for otherwiſe it could not form an inactive atom.

B Thirdly, it muſt preſerve a unity within itſelf, by acting ſo as to reſiſt whatever tends to deſtroy its unity (P, Q 164).

C The two firſt requiſites can only be united in a rotation of the portion of ACTIVE SUBSTANCE about a centre or axis at reſt. By ſuch a motion *all the parts* of the ſubſtance ſucceſſively occupy different places in the orbit of rotation, and therefore move; but the centre round which they revolve being at reſt, the *whole portion* is alſo at reſt; and thus the portion is at once moving and quieſcent as is required.

D Nor will any other motion than this anſwer to the requiſites given; for if all the parts move, as by the firſt requiſite, and do not revolve about a quieſcent centre, the centre, not being quieſcent, muſt move together with all the parts, and the whole will move, not only in its parts, but as a collective whole, and cannot therefore be in ſome reſpect, at reſt, as the ſecond requiſite makes neceſſary.

The ſame kind of motion will alſo fulfil the E
terms of the third requiſite. For a ſubſtance having a revolving motion around its own centre, preſerves its unity by reaſon of all the parts preſerving the ſame relation to the centre; and further, a motion of the ACTIVE SUBSTANCE about a centre or axis, will be an activity in the ſame orbit (T 165), which will act upon and reſiſt whatever ſhall interfere to oppoſe this activity, or deſtroy the unity of the ſphere, by diverting the courſe of the revolving motions.

The activity or motion of a portion of ACTIVE F
SUBSTANCE about a centre, will, therefore, give ſolidity to ſuch portion, for it will give it unity and reſiſtence, and in a manner tie together all the parts, forming them into one maſs about their common centre; for they move or are active not *towards* the centre, in which caſe they would be loſt in non-extenſion; nor *from* the centre, where they would diſſipate in boundleſs ſpace; but *about* the centre, preſerving the ſame limits of extenſion; and being in this way active, they in this way reſiſt any other activity oppoſed to them, that is, they reſiſt any action which

which tends to penetrate or divide this ſphere of revolving activity.

G Therefore, ſince any portion of ACTIVE SUBSTANCE does, by revolving about a centre, become an united, reſiſting, and quieſcent whole. The ſmalleſt portions of the ACTIVE SUBSTANCE which have ſuch motions, will become atoms, or make the ſmalleſt portions of matter (Q 164).

H Since, therefore, an atom is actually formed out of the ACTIVE SUBSTANCE by ſome certain modification of its activity; and ſince the modification above deſcribed, or a revolving motion about an axis will produce an atom, and no other modification whatever will ſerve this purpoſe; it is a juſt inference from theſe, that the ACTIVE SUBSTANCE does in certain caſes and in ſmall portions, aſſume revolving motions, each portion about its proper centre; and that theſe portions do by theſe modifications of their motions become corporeal atoms.

I For the admiſſion of any fact implies, alſo, the admiſſion as a fact, of whatever is neceſſary to the former; and *that* is neceſſary to any fact, which will alone ſerve to explain it: now reſiſtence can be explained only by action, and action can be explained by the motion of an active being alone; and the reſiſtence on all ſides of an extenſion, ſuch as a ſolid body, can be explained only by an action on all ſides; and an action on all ſides can be explained only by a motion of an active being circumſcribing on all ſides, the extenſion which reſiſts on all ſides; and the quieſcence of this reſiſting extenſion, cannot be explained but by this circumſcribing motion being equal and contrary on the oppoſite points of its motion; that is, in effect, by revolving in a ſphere, about a centre, which centre, ſo far as its own revolving motions are concerned, is at reſt. Such a modification of the ACTIVE SUBSTANCE being, therefore, neceſſary to the exiſtence of an atom, or of any ſolid maſs, muſt be admitted as matter of fact upon inference, becauſe neceſſary to a fact aſcertained upon ſenſible teſtimony.

Nor do I conceive this proof to be in its nature at all imperfect, or to fall ſhort of demonſtration: but if any one will refuſe it, it will be neceſſary for him to ſhow, either, that the explanation offered is not ſufficient, or that ſome other explanation may ſerve equally well. K

We may now alſo explain what at firſt may have appeared a paradox; how the ACTIVE L

SUBSTANCE, retaining its own nature and eſſential properties, continuing immaterial, unſolid, and active, puts on at the ſame time the form of matter, and becomes material, ſolid, and inert (H 150). A ſphere of revolving ACTIVE SUBSTANCE, as it revolves continually about a centre, and as parts of the ſubſtance, are conſidered as ſucceſſively paſſing through every point in the orbit; conſidered thus, in its parts, and in its motions, it is ACTIVE SUBSTANCE, immaterial, and unſolid; but the whole ſphere, conſidered unitically, collectively, and as quieſcent, is, in this point of view, a ſolid atom, material, and inert.

M Whether every reader will poſſeſs himſelf clearly and fully of my idea I know not: I have endeavoured as much as poſſible to diveſt it of the obſcurity apt to attend abſtracted reaſonings; and I believe, but little difficulty will ariſe to any intelligent mind, except ſuch, who, in their aſſociations of ideas, and acceptation of terms, have already, for a length of time, been habituated to a uſage foreign to that herein adopted.

N It is proper here to notice, that the ſimple cauſe, a revolving motion round a centre, produces the twofold effect, reſiſtence and reſt, or ſolidity and inertia, agreeable to the order of nature in other caſes, which is always to derive more complicated effects from more ſimple cauſes; but the modern philoſophy, in its principles, violates this order, inaſmuch as it requires two cauſes, VIS IMPRESSA and VIS INERTIÆ, to motion, a ſimple effect.

The relation between the ACTIVE SUBSTANCE O
which forms an atom, and the atom, may be aptly reſembled to the relation between a line and a circle.

The motion of a point generates a line; a line P
may therefore repreſent the motion by which it is generated. If the motion of the point deſcribes a part of the periphery of a circle, the periphery being completed, the moveable point has returned to the ſame ſituation from which it departed. The line being ſuppoſed to repreſent the motion by which it was formed, does this by the quantity of the diſtance to which its extremity has elongated from the point of departure.

The line, while it is deſcribing half the peri- Q
phery, continues to increaſe its diſtance, and repreſents a progreſſive and increaſing motion. While it is deſcribing the remaining ſemicircle, it is decreaſing its diſtance, till at length the

moveable point coincides again with the point of departure.

R Every portion of the periphery repreſents a motion, equal to the diſtance between the two extremities of that portion; but the whole periphery repreſents no motion.

S The periphery of the circle, therefore, conſidered in portions, exhibits a ſet of motions continually progreſſive, and every motion of ſome quantity or value, but whoſe collective ſum or reſult is nothing.

T And the reaſon of this is obvious; for the motion in any part of the periphery, is, in a direction, contrary to that of the motion in the oppoſite part of the periphery; and the ſum of the motions, in any half of the circumference, are contrary to the ſum of the motions in the oppoſite half; conſequently, ſince the motions in the whole circumference are contrary and equal, their reſult is nothing.

V A circle, therefore, is a figure deſcribed by motion, but which does not move; or, if the circle continually revolves about its own centre, the centre being at reſt, and the periphery revolving within itſelf, then every part of the periphery, and of the circle, moves, while the whole circle is at reſt.

A wheel turned round upon its axis, is an elucidation of all theſe obſervations, and an example of the union, in the ſame object, of activity and inertiæ, motion and reſt, to which we have traced the formation and exiſtence of every material atom. X

If we employ a geometrical figure, as a circle, to explain any thing here advanced, we mean not, however, to offer this as a complete illuſtration of any phyſical problem; and it is the more important to obviate the danger of expecting more, in phyſics, from geometry, than geometry can effect, becauſe there may be reaſon to apprehend that the modern philoſophy is not entirely exempted from this error. Y

Geometry treats only of figure and magnitude, abſtracted from phyſical power, actually exerted. As a power, exiſting, and producing its effect, differs from the meer contemplation of that power in the mind, and the rationale of its quantity, ſo do phyſics differ from geometry; that is, as the havoc and devaſtation of a cannonade differs from the parabolic curve lines, in the books of gunnery, which, lying peaceably on their ſhelf, repreſent the courſes of projectiles. Z

Mathematics

A Mathematics exiſt in the abſtract reaſonings of the mind; phyſics concern the phenomena of nature, the motions, buſtle, and buſineſs of the world.

B The ACTIVE SUBSTANCE is not an abſtract idea, but a phyſical power moving and acting. Its figure and dimenſions may be ſubjects of mathematical reaſoning, but this reaſoning can prove nothing concerning the exiſtence of the phyſical power; that muſt be proved in another manner.

C It is an error into which numbers fall, to imagine the modern ſyſtem is either founded upon, or receives any ſupport from mathematical proofs. The ſcience of mathematics being confined to abſtract ideas, can never afford any proofs concerning actual exiſtence or efficient power; and he who ſuppoſes that the powers which actuate the planets and other natural bodies, are, or can be, determined by geometry, however ſubtile or ſublime, is as much deceived as he would be, were he to hope to aſcertain the ſecret proceſſes of nature in the formation of the mineral, vegetable, and animal worlds, by reaſoning upon the properties of a cycloid; would he develop the intrigues of courts from the nature of a ſcalenus triangle; or direct the policy of ſtates, by deductions drawn from the equality between a whole and all its parts. In fine, the error is no leſs than endeavouring to explain the œconomy of a *living* world by the ſcience of *dead* quantity.

Should it therefore appear that the *mathematical* reaſonings applied to the modern philoſophy were in every part unimpeachable, yet it does not go the length of eſtabliſhing a ſingle fact; and the *phyſical* principles, incapable of receiving any ſuch auxiliary ſupport, muſt ſtand or fall by their own intrinſic merits or demerits. D

And thoſe who beſtow ſuch laviſh encomiums on the invention which introduced geometry to phyſics, making thereby a new and mixt mathematics, ſhould be careful to diſtinguiſh well, between *proofs* of actual exiſtences as principles in nature, and the application of ingenious reaſoning to *hypotheſes aſſumed as data*. E

Having ſeen the way in which an atom may be produced, we come to the ſecond problem, viz. F

TO EXPLAIN THE MANNER OF THE ATTACHMENT AMONG ATOMS. G

The

H The queſtion, how the parts of matter cohere, ſeems to have been the ultimatum of philoſophical reſearch. Men aſſumed the exiſtence of primary parts, and beginning with theſe, they endeavoured to ſolve the problem of the manner of their union.

I But here, alſo, we find ourſelves enveloped in an obſcurity, the offspring of our own errors. For imagining all matter to conſiſt of theſe primary atoms, and theſe atoms being conceived to be exceeding hard, impenetrable, and inert, two difficulties aroſe from this ſuppoſed ſtate of things.

K *Firſt*, Not having inquired how the atoms were formed, or became hard, or exiſted, or how the parts of an atom were united; the light which the knowledge of this would have reflected upon the coheſion of the ſame atoms was wanting: for it has been ſhown (o 85, &c.) and it is without doubt, that we ought to conſider the union of two atoms, as a ſimilar effect with the union of the two halves, or any two parts of one, and as proceeding from a ſimilar cauſe; conſequently, the formation of an atom, had it been known, would have been a preliminary diſcovery, leading naturally to the queſtion of the union of two atoms.

Secondly,

L *Secondly*, By aſſuming certain falſe data reſpecting the nature of atoms, men not only were deprived of an help which more juſt information would have afforded them, but became embarraſſed with poſitive and inſuperable difficulties, which aroſe not from the nature of the object inveſtigated, but from their own erroneous data.

M And theſe difficulties were two; *firſt*, from the extreme hardneſs and impenetrability aſcribed to atoms, no ſubſtance could be ſuppoſed to hold together two or more atoms by mutually piercing each, as bodies are attached by cements or intermedia, nothing could, in this way, lay hold of an atom, to bind it to another. *Secondly*, all matter being thought to conſiſt of like atoms, there was not any ſubſtance in nature which might ſerve as a bond of union between them: we were to conceive of no ſubſtances, but little unyielding maſſes, whoſe hard ſmooth ſurfaces might touch and eaſily ſlide over each other, but could in no conceivable way remain fixed together.

N I ſhall not enter largely into the various opinions to which this inquiry and theſe difficulties have given riſe. It has been ſuppoſed that the atoms were of an hooked form, and that theſe hooks, by entangling each other, held the atoms together; the only intelligible ſuppoſition, as it appears to me, of which the notion of impenetrable atoms will admit.

More modern philoſophers have rejected this ſuppoſition[a]; but, I think, neither on fair grounds, nor to ſubſtitute a better in its ſtead: they reject it on the ground that it is begging the queſtion; for, ſay they, How do the parts of the hooks cohere? This fact being *ſuppoſed*, without explanation, coheſion is aſſumed to explain coheſion. But the charge which the moderns bring againſt the notion of hooked atoms, does not hold good againſt the authors of this opinion only, but againſt all who maintain the doctrine of impenetrable atoms: for, whether the atoms be hooked, or ſpherical, or of whatever form they be, they equally ſuppoſe a power by which their own parts cohere. Since, therefore, both parties alike ſuppoſe hard atoms, they may as well ſuppoſe them of an hooked, as of any other form.

---

[a] Sir ISAAC NEWTON ſays, "The particles of all hard homogeneous bodies, which touch one another, cohere with a great force; to account for which, ſome philoſophers have recourſe to a kind of hooked atoms, which, in effect, is nothing elſe but to beg the queſtion. Others imagine that the particles of bodies are connected by reſt, *i.e.* in effect, by nothing at all; and others, by conſpiring motions, *i.e.* by a relative reſt among themſelves. For myſelf, it rather appears to me, that the particles of bodies *cohere* by an *attractive force*, whereby they tend mutually to each other."

Thoſe philoſophers who reject the explanation of coheſion by hooked particles, ſeem not to have been much more ſucceſsful in their own endeavours; they imagine that the particles of bodies cohere by an attractive force: but this, in fact, is no explanation at all; and, if it were, it is, on ſeveral accounts, liable to exception. It ſeems inconſiſtent to aſſign a *force* of any kind, as a cauſe of the coheſion of particles to each other, when the coheſion between the parts of any one particle, which is admitted to be vaſtly ſtronger, ſubſiſts without any force ſuppoſed. What is the origin and the ſeat of this force, it may be aſked? How is it ſo connected with the inert particles, as to make them tend forcibly towards each other? How does it act: by impulſe, or in what other way? Does it lay hold on contiguous parts, or encompaſs the entire atoms? Does it penetrate them, or act on their ſurfaces? What is its nature? Is it a ſubſtance, or a quality? Does it move, or remain at reſt? In fine, what is an attractive force, its nature, origin, ſeat, manner of operating, and how is its exiſtence proved? To all this it is no anſwer to ſay, it is a force which acts upon all bodies univerſally. This is only rendering the poſition more general, but not more clear or more certain; for ſtill the queſtions recur of this univerſal force, in like manner as we have propoſed them concerning the ſuppoſed attractive force of atoms. But further, as I ſaid, without going into theſe queſtions, the explanation, admitted as it is offered, is, in fact, no explanation at all; for that can be no explanation which merely gives a new term, without affording a new idea relative to the difficulty which is to be explained. Now, the term coheſion is employed to ſignify the fact of two bodies ſticking together; attraction is uſed to ſignify another fact, namely, the *tendency* of bodies, not in contact, to approach together; ſo that if the tendency to approximate be called attraction, the ſame tendency after contact may be called coheſion; and thus, attraction and coheſion ſignify only different circumſtances of the ſame fact or tendency. Now, it certainly would not be thought to explain any thing if it were ſaid that the parts of bodies cohered by a cohering force: neither, therefore, can it explain any more, to ſay they cohere by an attractive force; ſince attraction, if it ſignifies any thing different from coheſion, ſignifies a prior fact, *i. e.* a tendency to approach before contact: but if the tendency towards each other, *in* contact, called coheſion, is difficult to explain, is not the tendency towards each other, while at a *diſtance*, equally or more difficult? So that the attractive force, being as obſcure a thing as the cohering, it cannot elucidate the latter; and further, the attraction, if not the ſame with coheſion, differs only by including a prior fact; which, therefore, has no relation to the ſubſequent one, coheſion, required to be explained. Either, then, attraction is the ſame with coheſion, or it is a different fact, more obſcure, and diſtinct from coheſion; and, in either caſe, it gives no new idea concerning coheſion, and, therefore, does not at all explain this fact, but is a new term, conveying either no new idea, or, what is worſe, a foreign one, more obſcure than that it is employed to explain.

Q From theſe views of the ſtate of the inquiry, I think the concluſions are warranted, that the opinion of hooked atoms is unſatisfactory and hypothetical; and that the doctrine of attraction is ſtill leſs admiſſible, becauſe, at the ſame time that it is more unſatisfactory, it is leſs intelligible.

R Reſpecting the union of maſſes, originally formed, and exiſting diſtinct, the following poſitions muſt be admitted:

S Two atoms are held together, or united by ſome force, power, or action, becauſe there is a reſiſtence to their ſeparation.

T The uniting power of atoms muſt belong to its proper ſubſtance, or there muſt be, together with an uniting power, an uniting ſubſtance.

U The ſubſtance which ſerves to unite atoms, muſt have an union of its own parts; for, were it not united in itſelf, it could not impart union to any other thing; did not its parts cohere, they could not be the medium of coheſion to other parts.

X Being a power or action, that which unites atoms is the ACTIVE SUBSTANCE, becauſe nothing can act but what is active; and having an union of its own parts, it muſt be the ACTIVE SUBSTANCE, already conſtituted an atom; for an atom is the moſt ſimple united whole, formed out of the ACTIVE SUBSTANCE, as above deſcribed (G 168). Nothing more ſimple than an atom can exiſt, to unite other atoms; and nothing more compound can be admitted for this purpoſe.

Y Therefore, the atoms are immediately united to each other, without any medium, and without any other power than their own conſtituent power or innate activity, whereby themſelves exiſt, as united and reſiſting wholes.

Z Two ſubſtances exiſting diſtinct in themſelves cannot become united while at a diſtance from each other, nor by meer approximation and contact alone; for an union implies the deſtruction of that diſtinct exiſtence which the two ſubſtances are ſuppoſed to have, prior to their union: but neither diſtance nor contact deſtroys that diſtinct exiſtence; the ſubſtances ſtill remain diſtinct, are two and not one.

A In order, therefore, that two atoms ſhould be immediately knit and held together of themſelves, and without any intermediate or foreign action (Y 182), there muſt be ſomething more than a touching of their ſurfaces, that is, there muſt be an union or an intermixture, mutually, of part of the ſubſtance of each atom.

B I ſay there muſt be an union of *part* of the ſubſtance mutually of each atom; for if the whole of each atom were mutually united, they would not be two atoms in union, but one atom: but part of each atom being united, reciprocally, there is then a continuity, an union of the ſubſtance of the two atoms, in ſuch ſort, that the two atoms can neither be ſaid to be any longer wholly diſtinct, nor are they become entirely one, but they are two atoms, whoſe ſeparate exiſtence is partially deſtroyed, and while they retain ſome ſort of diſtinctneſs, they alſo partake of an union; they are two atoms in one ſubſtance or continuous maſs. If two balls of wax are warmed at their ſurfaces and ſtick together, ſo that the figure of the two balls in part remains, but is deſtroyed at their junction, giving thus the idea of two balls, forming one piece of wax, this will be illuſtrative of the union, above explained, between two atoms.

C This ſort of union, by a mutual penetration of parts with parts of atoms, we have here ſhewn to be neceſſary to any coheſion or attachment, whereby larger maſſes can be formed from the firſt atoms; and this neceſſity appears, and we have inſiſted upon it, independent of any theory reſpecting the nature of atoms, as admitting of ſuch mutual penetration, or not.

D The inert and impenetrable atoms of the modern philoſophy, certainly militate againſt any ſuch mode of coheſion; and it is as certain no other mode can be conceived, but either the hypotheſis of hooks, or the admiſſion of a new agent, contrived on purpoſe for this end; but any other agent is wholly unknown, and the idea of hooks hardly deſerves a ſerious refutal, when we conſider the diverſity of forms and actions, among the minute parts of nature.

E Our theory of atoms, comports with this mode of coheſion, which, independent of that theory, we have ſhown, muſt actually have place.

F Our explanation of coheſion requires the mutual penetration of the atoms; and atoms, according to the foregoing theory, are not impenetrable, but reſiſt only, in a certain degree, proportional to the quantity of the revolving motion, *i. e.* the action which conſtitutes the atom; alſo, in a certain ſenſe, atoms do not mutually reſiſt penetration. The reſiſtence of an atom, or of any ſolid, is only to any other ſolid; but to the ACTIVE SUBSTANCE, conſidered as unſolid, a ſolid oppoſes no reſiſtence (F 85). Now an atom, being the ſmalleſt entire ſolid, is ſolid only as a collective whole, and as a collective whole it both reſiſts and is reſiſted. But the revolving motion, which forms the atom, has been ſhewn to be, in every part, taken by itſelf, a motive, unſolid, ACTIVE SUBSTANCE: the revolving ſubſtances of two atoms may, therefore, mutually penetrate, near their circumferences, and interchangeably unite; and this portion, intermediate and common to each atom, will be the bond of union, and the tie which attaches them to each other.

G The theory of any particular fact muſt be allowed to receive conſiderable ſtrength by its analogy with other parts of nature aſcertained by ſenſible teſtimony. And ſince it is certain that all our knowledge of external things is attained through the medium of our ſenſes, we can form no other ideas of beings and operations which are too ſubtile for the notice of our bodily organs, but by conceiving of them in a manner ſimilar to actual phenomena. It is thus the hypotheſis of hooked atoms, whatever objections it may be liable to, has ſome analogies, and is intelligible, becauſe it correſponds with ſome ſenſible appearances.

H But the theory above laid down, has a far more extenſive analogy, beſides that it affords an adequate ground of application to the *varieties* of nature, and, above all, is not hypothetical, but deduced from phenomena. We ſee few, except artificial bodies, of an hooked figure, and attached by their hooks; nature, therefore, affords but a ſlender analogy of this kind. But, almoſt univerſally, we ſee bodies united by a mutual incorporation and introſuſception of each others ſubſtances: ſoft wax, clays, gums, reſins, the grafts of trees, and the reunion of living animal ſubſtances, are examples. The ſame thing happens when *intermedia* are employed: hard ſubſtances, whoſe parts mutually reſiſt penetration, cannot, for that reaſon, of themſelves remain attached; but the glue which cements two ſurfaces of wood, in its fluid ſtate, while hot, penetrates either ſubſtance, and unites its active powers with the contiguous corpuſcles of the wood, and becoming fixed, when cold, the pieces of wood, thus united, on either ſide, to the hard glue, are, by its intervention, firmly held to each other. Our theory deſcribes the union of the primitive corpuſcles agreeable to theſe ſenſible facts, and this redundant hiſtory of analogies. I truſt it will appear more dignified by its ſimplicity; and its conſanguinity with familiar facts will be deemed, at leaſt, one characteriſtic of its truth.

The coheſion of the minute parts comprehends 1
a great diverſity, which appears in the ſtructure and modification of bodies: not only the varieties of hardneſs and ſoftneſs, brittleneſs and malleability or tenacity, fixedneſs and fluidity, elaſticity, and inelaſticity; but no doubt, alſo, all the ſenſible qualities of bodies, as odours, colours, vapours, and the ſtructure and organization of different ſpecies, both of inanimate

and animate beings. A perfect theory of cohesion ought to afford explanations of all theſe diverſities; it ought, alſo, to throw a light upon that oppoſite fact called repulſion, in which the parts of bodies manifeſt a tendency to recede from each other: but it came firſt in order to give, what hitherto has been a *deſideratum*, a theory of the general fact of coheſion, previous to the inveſtigation of its varieties, and deviations.

K And we are ready to confeſs, that although we can diſcern, in the theory laid down, a copious field of variety, adequate to all the purpoſes required, we have as yet ſeen but obſcurely the immediate applications to each particular caſe; and without, at this time, proſecuting more into its minutiæ, an inquiry, the ſatisfaction reſulting from which we cannot hope will be complete, we ſhall content ourſelves with having cleared the way, and at leaſt, as we hope, ſet forward in the right road, leaving yet an ample ſcope for the induſtry of others in making further advances.

L I ſhall conclude this part with a remark that I have frequently had occaſion to make, the importance and pertinence of which entitles it to notice here.

I have thought it neceſſary to diſcourſe, *firſt*, on the general fact of coheſion, and leave its varieties to a future diſcuſſion, of which the general principles muſt be the baſis. But we continually ſee men purſue a contrary method; they ſeek explanations of certain varieties of general facts, or deviations from the ordinary courſe of things, without thinking it previouſly neceſſary to inveſtigate thoſe general facts, about which they are alſo ignorant. I ſhall adduce ſome examples to illuſtrate my meaning.

Philoſophers have long, as I before ſaid, conſidered the queſtion how the particles of bodies cohere to each other, without having firſt aſcertained what ſort of things thoſe particles were. This is as if a man ſhould contrive a means of faſtening together two bodies, without learning what ſort of bodies they were, whether ſolid or fluid, ſoft or hard, ſtone or vapour. Men began to inquire the cauſe of eclipſes, who yet had never thought of diſcovering the reaſon of the more regular appearances of the ſun and moon. The laws and cauſes of the variation of the compaſs have been the ſubject of numerous inveſtigations, but how few have thought it previouſly neceſſary to inveſtigate the cauſe of the general tendency of the needle towards the North and South; and how neceſſary is this inquiry as a baſis for the former: for the cauſe of each variation from itſelf, ought to be ſought in ſome variation of the general cauſe, by which the needle points at all, and prefers one direction to another. Hiſtorians have laboured to develop the ſources of wars, rebellions, revolutions, and remarkable events, with much more aſſiduity than has been beſtowed to get juſt notions of the nature of that influence by which a government exiſts, and flows peaceably in its accuſtomed channels. Men are ordinarily ſolicitous to know the nature and cauſe of diſeaſes, of blemiſhes, of preternatural appearances in our bodies, but indifferent as to the proceedings of the healthy œconomy: we have an hundred diſſertations on fever for one upon life; we are more deſirous to know how we are diſordered than how we exiſt, and expect to be able to determine why the pulſe beats unuſually faſt, notwithſtanding we are ignorant why it beats at all. The action of ſtimuli, and the irratibility of the living fibre, have been the ſubjects of many ingenious diſcuſſions; the regular and uniform action of the fibre, of much fewer. A voluntary muſcle in action, is contracted in its length, hardened in its conſiſtence, and coheres more ſtrongly, ſo as to ſuſtain much greater tenſion, without dilaceration, than the ſame muſcle not in its ſtate of voluntary action; theſe accidental conditions have, at all times, attracted the notice of phyſiologiſts; but, in order to account for them, few, if any, have thought it neceſſary to inquire firſt, the manner in which the muſcle had its natural conſiſtence and degree of coheſion; expecting vainly to account for an irregular and extraordinary circumſtance of coheſion, appearing in a living muſcle, whereby it undergoes great and ſudden variations, dependent on a complicated ſyſtem of parts and connected agencies, without underſtanding the nature of coheſion in its moſt ſimple ſtate, between two primary parts of matter. With as reaſonable a proſpect of ſucceſs, might a man, ignorant of the moſt familiar truths in mechanics, attempt to explain the movements of the moſt elaborate and complicated machine.

Various are the ſources of this ſoleciſm in the method of purſuing knowledge; habit, indolence, emulation, and other cauſes, contribute to its production. It is the natural diſpoſition of the infantile and the untutored mind, to be taken only with novelties, and to be inattentive to accuſtomed appearances. Every object, indeed, in nature claims our notice, but we cannot attend to all; familiar ones we regard with indifference, becauſe they are familiar, and fly with avidity to new ſcenes.

The deſire to exerciſe our talents, and achieve ſome new diſcovery, ſets us to work; but indolence prevents us from carrying our reſearches deep, in order to gain a firm baſis; we ſkim the ſurface, and content ourſelves with ſpecious errors, or pompous trifles.

In practical affairs, men are compelled to act upon imperfect knowledge: a general muſt ſometimes direct his movements on intelligence which may deceive him: a court muſt give ſentence, ſubject to a poſſibility of error: a phyſician muſt preſcribe, on the moſt probable conjectures, in an equivocal diſeaſe. But in thoſe ſpeculations, wherein immediate practice is not concerned, and which are undertaken, at our leiſure, for the advancement of theoretical knowledge, and the benefit of men in the actual concerns of life, at a future period; in theſe, there can be no good reaſon why we ſhould begin at the wrong end, and waſte our labour in unavailing purſuits of what we can never attain, without going through a number of preliminary ſteps, which we injudiciouſly neglect.

C H A P. VII.

Of the Conſtructive Analogy between the Primary Corpuſcles, the Planets with their Syſtems, the Solar Syſtem, and the Fixed Stars.

ON the ſame grounds, and in like manner as we have ſhown the conſtruction of the primary particles, we may evince a ſimilar conſtruction to obtain in the larger parts of nature. A

It will not be uſeleſs here to recapitulate the arguments before employed, previous to their more extenſive application, as now propoſed. B

From the ſenſible qualities of matter we deduced, by inference, its actual but ſecret laws of exiſtence. C

The qualities from which we deduced the formation of matter and its manner of exiſtence, were its SOLIDITY and its INACTIVITY. D

E We conſidered ſenſible maſſes of matter as compounded of ſolid parts and pores, that is, as not entirely ſolid, or wholly matter, but comprehending void ſpaces between the parts of matter; and we concluded that if any maſs were divided wherever pores interrupt its continuity, we ſhould at length arrive at ſolid parts, which contained no pore: theſe imporous parts, ultimate in this order of decompoſition, we called primary in the productive order of nature.

F To theſe little imperceptible original maſſes, corpuſcles, or atoms, we transfer our ideas, and regard the qualities of SOLIDITY and INACTIVITY as ſubſiſting in them; and it is neceſſary, in order to attend diſtinctly and purely to the idea of ſolidity, to conſider it uninterruptedly in a maſs devoid of pore, and which is ſolid throughout.

G From *ſolidity*, as a ſenſible quality, we infer *activity* as its immediate cauſe; and we infer it on the ground, that ſolidity conſiſts in reſiſting action: we call that ſolid, which, when we preſs, or pull, or any way endeavour to change its dimenſions or figure, oppoſes reſiſtence to our endeavours. In a more limited ſenſe, fluids are ſolid, inaſmuch as they reſiſt compreſſion. Reſiſtence to action, we ſay, is action; an action becomes reſiſtence, by its being conſidered as oppoſed to any other action, but without action there is no reſiſtence; for to reſiſt is to impede, obſtruct, or prevent, all of which imply action.

Since, therefore, ſolidity implies activity, every part of a ſolid atom being ſolid, every part is active, and the ſubſtance of the atom being ſolid, it is alſo active. H

We regard an atom as the leaſt and the moſt ſimple ſolid. If an atom ſhould be divided, the divided parts would contain the ACTIVE SUBSTANCE of the atom, but they would not be ſmaller atoms, or ſolid maſſes leſs than the atom; for if the divided portions of an atom were yet ſolid, an atom would not be the leaſt ſolid, nor a primary part of matter. I

It is, therefore, only the *whole atom* which can be ſaid to be material, and the parts, conſidered ſeparately, are not material, becauſe the material nature reſults only from the whole conſtruction. A certain conſtruction of parts conſtitutes a watch, but the whole, only, is a watch, and not each ſeparate wheel or part. K

This follows, alſo, from what precedes (H 195): we have, by referring ſolidity to activity, and L making an atom active throughout, becauſe throughout ſolid, aſſigned to matter two qualities, which ſeem incompatible; or more ſtrictly we have aſſigned to it a quality, ACTIVITY, and, at the ſame time, a negation of that quality; ſince beſides ſolidity, the other property we diſcover, by our ſenſes, in matter, is INACTIVITY.

M *Inactivity* is an obvious quality of body; *activity* is a quality not obvious, but inferred from ſolidity. If matter be at once *inactive* and *active*, it muſt be in different reſpects: the inactivity being the more obvious quality, muſt belong to the whole collectively, and the activity being that which only is inferred, muſt belong to the parts. But ſince it is to the parts of an atom, taken ſeparately, we muſt allow activity, and to the whole, collectively, we muſt deny it, the parts which poſſeſs activity, muſt be a different kind of being from the whole, which poſſeſſes it not.

N Having thus been led to a diviſion or decompoſition of a ſubſtance, viz. matter, which produces a different ſubſtance, we reſemble this proceſs of ratiocination to thoſe chemical analyſes, whereby, from ſpecies of certain obvious and ſenſible qualities, other ſpecies reſult, the qualities of which were before concealed.

While we call the entire atom matter, it being o like all matter ſolid and inactive, we call its conſtituent parts, or the ſubſtance of the atom, conſidered as unfolded, divided, and no longer held together in unity in the atom, the ACTIVE SUBSTANCE, and pronounce it IMMATERIAL.

We next inquire in what manner we are to p underſtand the activity of the ACTIVE SUBSTANCE, or to what intelligible idea activity can be referred, and we find it to conſiſt in motion; for activity muſt either relate to motion or to reſt; but it cannot relate to reſt, which is nothing, and requires no producer; it relates therefore to motion. In bodies, from whence we gather, originally, our application of the term activity, we find two ſtates, in both of which they are ſaid to be active; both of theſe have a reference to motion; one is when bodies actually move, the other is when they impel or *tend* to move: nothing is called active but what does one of theſe. But impulſe is the effect of ſolidity, or of the reſiſtence of matter actually exiſting; the ACTIVE SUBSTANCE, therefore, not being matter, cannot impel or be impelled, or cannot tend to move without actually moving: therefore, this immaterial ſubſtance muſt move, and on its motion its activity muſt depend.

Q We therefore, now, may expreſs the *activity* of the parts of the atom, or the ACTIVE SUBSTANCE by its *motion;* and the *inactivity* of the entire atom, by its *reſt;* and we may ſay the *parts* continually move, while the *whole* is at reſt, as we before ſaid, the parts were *active*, while the whole was *inert*.

R As the parts conſtitute the whole, the ACTIVE SUBSTANCE conſtitutes the atom; and the ACTIVE SUBSTANCE, by its own nature, conſtitutes the nature of the atom. Now, the nature of the ACTIVE SUBSTANCE is motive; and by this its motive nature, it conſtitutes the nature of the atom, ſolid and quieſcent.

S But in order that motion of parts ſhould conſtitute reſt of the whole, the moving parts muſt have contrary motions, in equal quantities, from which will reſult the quieſcence of the whole; and to do this, the moving parts muſt revolve about a centre at reſt, either in circles or in ſome curvilinear orbits.

T And ſuch a motion, beſides producing the quieſcence of the whole, whoſe parts ſo move, will alſo produce the ſolidity of that whole; that is the orbicular motion will be an activity, capable, in every part, of reſiſting other activities.

And that which is at reſt, and reſiſts in every U part to extraneous actions, is a ſolid.

The orbicular motion of the ACTIVE SUBSTANCE, that is, of an immaterial ſubſtance, X will produce an atom, or a material being; and no other modification of motion will afford this reſult. On this ground we infer, that the ACTIVE SUBSTANCE does actually form ſuch orbicular motions, about quieſcent centres, and does, by this means, conſtitute the primary parts of matter.

Such, in a general view, has been the method Y of reaſoning employed, and the ſteps by which we have arrived thus far: and we ſhall now proceed to a more extenſive application of the ſame.

The obvious and ſenſible qualities of bodies, Z ſolidity and inertia, we transferred, in idea, from ſenſible maſſes, to minute parts imperceptible to ſenſe; but we may, alſo, conſider theſe qualities in the larger portions of the creation;— the earth and the other planets: again, we may *infer* the ſame qualities of other, and larger ſpheres of exiſtence; ſuch as the orbits in which the planets, primary and ſecondary, revolve; the whole mundane ſyſtem; the ſyſtems of the fixed ſtars; laſtly, of the entire univerſe.

A Each, and all of theſe, reſpectively, we may pronounce to be, in a certain ſenſe, ſolid and inert; that is, to partake of the nature of matter.

B We muſt recollect, that the inactivity of which we all along ſpeak, or the quieſcence we attribute to material exiſtences, is not an *actual*, but a *natural* reſt. All bodies are moveable, or ſubject to occaſional activities; but theſe activities are conſidered as accidental or extraneous, and not as at all to be regarded in conſidering the nature of bodies. No atom has an actual reſt, although we aſcribe reſt to them. We mean, that reſt muſt be the reſult of their own conſtitution and innate action; and if they are made to move by foreign cauſes, we do not take theſe motions into our preſent conſideration. So of all the things above enumerated, when we pronounce them to be quieſcent, we mean that they are ſo, relative to any internal activities which belong to them, and conſtitute them, and have no motions but what are induced from without, and ſuch they actually have.

Reſt, or inertia, being thus underſtood, and C
ſolidity, as already explained, to conſiſt in a reſiſtence about a circumſcribed extenſion, theſe may be predicated of every diſtinct maſs, ſphere, or extent of being, from the primary particles, to the whole univerſe.

That the earth is a ſolid body, we know by D
our touch; that the other planets and ſtars are ſo, we gather from their emitting or reflecting light to our viſual organs, and from other analogies. The motions of the planets are conſidered as induced by extraneous cauſes; and relative to the actions carrying on within themſelves, they are at reſt; theſe actions, proper to each body, being on the whole, equal in contrary directions. Theſe bodies, therefore, have the qualities belonging to all matter, ſolidity and inertia.

That the ſpheres, circumſcribed within the E
orbits of the ſeveral planets, are alſo ſolid and inert, and conſequently material, is leſs obvious, and ſuch language is leſs conſonant to our habits of ſpeech; but, I apprehend, it may be made to appear with equal certainty.

A ſolid is a circumſcribed being, which, F
from its own internal activities, reſiſts on all

ſides. No preſcribed quantity of reſiſtence is neceſſary, that may vary indefinitely. In order to ſolidity, a being need not reſiſt as much as iron or wood or air; it may be far leſs denſe than theſe, and yet be ſolid, provided it reſiſts on all ſides.

G The term ſolid is applied to a ſpecies of being having a determinate character, that is, a circumſcribed reſiſtence; not to any fixed degrees of that reſiſtence. As there may be inviſible ſolids, like air diſcovered by the touch, ſo there may be intangible ones, diſcovered by inference from other phenomena. Tangibility belongs to that degree of reſiſtence, in ſolids, which is capable of producing a certain change on ſuch ſolids as our organs: a leſs degree will fail of being manifeſt to our touch; but philoſophers are abundantly convinced, that one ſenſe is not the criterion of exiſtence, but ſuch inferences as reſult from the teſtimony of all. It is the property of fire to give the feeling of heat, but not of all degrees of fire; for we are aſſured of the preſence of fire in bodies, which are cold to our ſenſe. Light may be proved to exiſt, where the eye would announce a total darkneſs.

H In like manner, matter has its degrees of intenſity. Water is leſs denſe than ſtone, air than water, vapour than air, light than vapour; and as light is intangible, excepting to the optic nerve, why may not matter ſtill leſs denſe than light exiſt, to us inviſible as well as intangible?

We ſhall not, therefore, be miſunderſtood, I when we ſay the planetary ſpheres are material, that we think them groſs, like the matter around us, or that we adopt the ſolid orbs of the Ptolemaic ſyſtem, or the denſe ſubſtance of the vortices of Des Cartes. But we ſay the celeſtial orbits exhibit evident proofs of their being *circumſcribed extenſions, reſiſting on all ſides*, and inert; and of having, thus, the characteriſtics of matter, and being altogether ſimilar to ſenſible bodies, except a difference in degree.

We know from obſervation, that a ſphere of K activity extends to ſome diſtance around our earth: and we ſhall conſider it as a *datum* that ſimilar ſpheres extend around all the planets, and the ſun; by which they interchange a mutual influence; and, alſo, about the fixed ſtars, although their agency is leſs apparent to us. To what limits theſe ſpheres of activity extend, about each celeſtial body, we do not here inquire.

L The phenomena of falling bodies in different parts of the atmoſphere ſurrounding our earth may ſerve to illuſtrate the diſtinction we wiſh to have clearly underſtood, between the part of an atom, and the whole. Since, on every part of the earth's ſurface, bodies fall, the agency, therefore, by which they fall, extends all round the earth. The whole of this ſphere of agency we call a ſphere of matter, leſs denſe than our earth, and enveloping it; but if we ſpeak of any ſeparate part, we call it immaterial. Thus it is an *immaterial* ſubſtance and agency which cauſes a ſtone to fall; becauſe this is done by a portion of the ſphere: in each portion the ſphere is active, in the whole inert; in *each part immaterial, as a whole, a material* but rare and ſubtle orb.

M The unity and order of each diſtinct ſyſtem, and of the entire univerſe, demonſtrate a mutual reſiſtence to each other, and, at the ſame time, a mutual attachment of theſe ſpheres of activity.

N The earth and moon, in their revolution about the ſun, carry along with them their reſpective ſpheres of activity; but neither penetrates, nor is penetrated by the other. The ſame may be ſaid of Jupiter and Saturn, with their moons;

and all the planets, with the ſun, revolving about their common centre, preſerve their diſtances from that centre; and ſince the very being of the univerſe depends upon every part preſerving its proper diſtance from every other, there can be no doubt but a powerful agency is prepared to *reſiſt* any tendency, actual or poſſible, to the falling together of the celeſtial bodies.

It is equally eſſential to the preſent ſtate of O
things, that the planets are not too widely ſcattered aſunder, as that they do not approximate too near; and that every part, planets, ſun, and fixed ſtars, neither encroach upon each others limits, nor any of them fly off, detached and loſt from the ſyſtem, into boundleſs ſpace: hence it is as evident that there exiſts an *attaching* force to preſerve the connection and order of theſe parts, as it is that there exiſts a *propelling* power, to prevent their ruſhing together into one common maſs.

Without an attaching power, the unity of the P
whole could not be preſerved; without a reſiſting, the diſtinctneſs of parts muſt be deſtroyed.

This two-fold power, which is neceſſary to the Q
exiſtence of the larger planetary ſyſtem, we have before ſhewn to be neceſſary to the exiſtence of a ſingle

a ſingle atom; that is, a reſiſtence of the parts to a nearer approach, and to a more diſtant receſs (E, &c. 29), and in this we perceive a perfect ſimilitude between the nature of the general ſyſtem, and of the ſmalleſt atom.

R If we regard any ſingle ſphere of activity, we may reſemble it to a ſingle atom. It is a complete exiſtence in itſelf; a whole, formed of its own parts. Thus we may regard the ſphere of the earth's activity, of the moon's, of Jupiter's, Saturn's, or the ſun's.

S If we regard any of theſe ſpheres in their relation to other ſpheres, we may reſemble them to atoms in their relation as cohering to other atoms.

T Thus the ſpheres of the earth and moon cohere together; of Jupiter and his ſatellites; of Saturn and his ſatellites; and theſe may be conſidered, again, as compound maſſes, which, together with the ſpheres of the other planets, all cohere with the ſphere of the ſun's activity, or are involved in it.

U Again, the whole ſphere of our ſolar ſyſtem *coheres* with contiguous ſpheres of the neareſt fixed ſtars; and each of theſe immenſe orbs of activity may be regarded as an *atom*, in relation to the whole univerſe; and the univerſe as a *quieſcent maſs* conſtituted by the coheſion of theſe atoms, in a manner analogous to the formation of any ſmall and more denſe body, by its component atoms.

Our habit of conceiving the planets to revolve in ſpaces almoſt or altogether void, and as *attracting* each other, at great diſtance, through this void, may impede the familiar conception of theſe ſpheres of activity, as extenſions of actual and ACTIVE SUBSTANCE diffuſed around each planet: but we have, all along, aſſumed it as evident, that where there is *action*, there is *ſubſtantial exiſtence*, and conſequently that to whatever apparent diſtance bodies maniſeſt that power called *attraction*, it is not truly a diſtant action, but the action of a ſubſtance, preſent where it acts, and conſequently extended about the central globe (ſaid to poſſeſs the attractive force), to the diſtance of the body acted upon. The planets, therefore, cannot be ſaid to attract or act upon each other, at a diſtance, or through void extenſions; their ſpheres of attraction, as they are called, are ſpheres of an ACTIVE SUBSTANCE, leſs denſe than the planet which occupies the centre of thoſe ſpheres; and the active ſphere of each planet acts not on the *body* of another planet, but on the *active ſphere* of that other planet, extended ſo as to interſect the former. This idea is not diſſonant to the opinion of Newton, who expreſsly rejects the notion of bodies acting at a diſtance, as being what no philoſopher can entertain.

Y The analogy we have obſerved between the ſeparate ſpheres of activity, which encompaſs each their proper central body or planet, and the primary atoms; and between the attachment of theſe ſpheres, and the coheſion of thoſe atoms, leads us neceſſarily to a ſimilar method of inveſtigation in each, and we have here, as in the inquiry concerning the formation of matter, two diſtinct facts to diſcourſe upon, in their proper order; *firſt*, the formation of any ſingle ſphere of activity; *ſecondly*, the mutual attachment of thoſe ſpheres.

Z And in each of theſe, the ſimilitude of the facts leads preciſely, by the ſame ſteps, to the ſame concluſion. (See Ch. 6. P. 2.) Each ſphere, that of the earth for example, in all its parts, ſeparately taken, is active; whether we regard this ſphere as acting on that of the moon, to retain it within its proper limits, or in the more familiar facts of gravitation, near the ſurface of the earth, we ſee it actively demonſtrated;

but the equality of all theſe actions on oppoſite ſides, makes their reſult nothing, and the whole ſphere as an unit inactive: accordingly, philoſophers are agreed, that the earth is not moved by the gravitating tendencies upon its ſurface, becauſe they are contrary and equal.

But this activity of parts, and theſe various actions of gravitation, carrying on above the earth's ſurface, in a medium of ACTIVE SUBSTANCE, are produced by the *motion* of that ſubſtance (z 166), and as the activity *exiſts* only in ſeparate parts, and is *nothing* in the collective whole, ſo the motions, in like manner, muſt be *motions of parts*, which reſult in the *reſt of the whole*. A

And ſuch a motion can be no other than a revolving motion about a quieſcent centre: AND HENCE WE INFER THAT THE ACTIVE SPHERES WHICH ENCOMPASS, SEVERALLY, EACH SECONDARY PLANET, PRIMARY PLANET, THE SUN, AND EVERY FIXED STAR, ARE SPHERES REVOLVING ABOUT THEIR PROPER CENTRES, AND THAT BY THIS REVOLVING MOTION THEY EXIST, AND PERFORM THEIR ACTIONS. B

Reſpecting the coheſion of theſe ſpheres, we ſay they cannot hold each other together by any C diſtant action; neither by ſimply coming in contact at their ſurfaces; but it is neceſſary that parts of two attached ſpheres ſhould interſect each other, and that their ſubſtances at theſe interſecting parts ſhould intermix, and their actions be blended in ſuch ſort as to conſtitute theſe conjoined portions, common to either ſphere, the bond of attachment between both.

D In the celeſtial machinery there are two ſpecies of *attachment* to be traced. The *firſt* is that of ſpheres interſecting each other, in portions, the remaining portions extending without each other; the *ſecond* ſpecies of attachment is when leſs ſpheres are *wholly contained* within greater.

E The ſphere of our ſolar ſyſtem can only be connected to the ſpheres of the fixed ſtars by interſection of portions of the ſpheres; but the ſmaller ſpheres of the planets belonging to our ſyſtem, are contained, and wholly enveloped within that larger ſphere.

F When any ſphere of activity involves another ſphere, in ſuch a manner that the involved ſphere is *ſingly* acted upon by the other, in which it is contained, it will neceſſarily follow that this contained ſphere will be carried about the centre of the other ſphere, by the revolving motion of that other; or, that each ſphere will be carried about a common centre by the conjoined revolving motions of each.

From hence the revolutions, both of the primary and ſecondary planets, aſcertained by obſervations, might be demonſtrated *a priori*, could their relative diſtances be aſcertained, independent of the knowledge of their motions. G

The moon and earth, by their vicinity, ought to revolve, by the mutual actions of their ſpheres of activity, about a centre common to both. H

The ſame may be ſaid of the other ſatellites, reſpecting their primaries. I

All of theſe, primaries and ſecondaries, being involved within a larger and parent ſphere, ought to be carried about a common centre, by that larger vortex. K

But, at leaſt, the foregoing principles ſerve to afford a cauſe, true, ſufficient, and intelligible, of the revolutions of the celeſtial bodies. L

When, in the *ſecond* ſpecies of *attachment*, any ſphere, inſtead of being ſingly acted upon by another ſphere, is, at ſeveral parts, interſected M by ſeveral other ſurrounding ſpheres, and attached, in this manner to each, ſuch a ſphere cannot be carried about the centre of any other ſphere, becauſe it is attached to *ſeveral*, but muſt remain at reſt.

N Hence appears the reaſon why the ſun and fixed ſtars are, relatively to each other, at reſt, and form a quieſcent maſs, or an univerſe fixed and immovable.

O For the multitudinous ſpheres of the fixed ſtars, ſurrounding each other on all ſides, and each being, in various parts, interſected by its contiguous ſurrounding ſpheres, and held to each by the interſected portions, every ſphere muſt, thus, be retained at reſt.

P And wherever the univerſe has its boundaries, the external ſpheres, although they cannot, like the internal ones, be ſurrounded by other ſpheres, may yet be each attached to ſeveral others, and being held by each, be prevented from obeying the revolving motion of either, and thus, alſo, retained at reſt.

Q And if our viſible univerſe be a whole, unconnected with any other creation, and not forming a part of a ſtill larger ſyſtem of being, it ought, by our principles, to poſſeſs ACTUAL REST, while all its component parts ſubſiſt, and conſtitute that whole, by their ACTUAL MOTIONS.

But if our viſible creation be only a part of a larger one, a link of a more extended chain, which embraces wider and remoter regions, than thoſe from whence the ſmalleſt teleſcopic ſtar darts its rays, then by the ſame principles, and by the general analogy of things, *our univerſe* muſt have its *proper motion* in that LARGER SYSTEM, of which it is but a component part, and which other and unknown worlds combine to frame.

END OF THE SECOND PART.

PART III.

A further Inveſtigation of the Nature and Laws of the ACTIVE *or* ELEMENTARY SUBSTANCE.

CHAP. I.

Origin of Phyſical Power, exemplified in Elaſtic Bodies, Inflammable Bodies, Chemical Operations, Living Proceſſes, and Gravity.

A THERE is a power of volition, and a power which, ſo far as obſervation can go, appears to be independent of volition; this latter is called phyſical power.

B Activity, and conſequently power [a], has been found to have its origin in motion.

---

[a] See Definitions.

C But it is phyſical power or activity, alone, which we mean to conſider as derived from motion. The activity, or power of mind, we do not, in this place, take into conſideration.

D If power proceed from, or rather belong to motion, whence does the motion, in all caſes, proceed?

E An impelling body, being in motion before it impelled, may be conceived to be a vehicle of ſomething motive, which it can impart in the impulſe; but when no motion is ſeen to *precede* an action or exertion of power, only to *follow* it, whence can it be ſuppoſed the motion proceeds? Whence the motion of falling, generated in a body, when left without a ſupport? Whence that, in an elaſtic ſubſtance, left to itſelf, after compreſſure? Whence that, proceeding from inflammable bodies, as gunpowder? Whence the inteſtine motions of chemical changes, thoſe of vegetation, or of animal life?

F It appears from what has been ſhewn to be the conſtitution of matter, that all bodies contain within them a ſource of motion, though themſelves be at reſt.

For the primary component parts, or atoms, are ſo many little ſpheres, revolving about their proper centres; and thus the whole maſs of every body is made up of motion, exiſts by motion, and is full of motion; it is, therefore, an obvious ſource, out of which motion may proceed. G

But bodies neither are moved by their own internal motions, nor immediately generate other motions except placed in particular circumſtances, not natural: an elaſtic body produces no motion unleſs it be firſt compreſſed; nor inflammable bodies, unleſs fire be applied to them. H

Some acceſſary circumſtances are, therefore, neceſſary in order that bodies ſhould *give out* a portion of their internal motion, which, in their natural and ordinary ſtate, is deſtined and employed for the maintenance of the body, and which circulates and abides within it. I

The bending of ſteel, or of any elaſtic body, puts it in a preternatural ſtate. The bended body preſſes on whatever detains it, and by preſſing, continually *pours out* a current from within it (R 127); and when the body is no longer forcibly detained in a bended form, it reſtores itſelf, that is, its parts begin to move, and regain their natural ſtate, after which the body exerts no K impulſe, nor *gives out* any motion. Agreebly to this, moſt bodies are found to diminiſh of their elaſticity, after a time, by remaining bended; the internal ſtructure is changed, or its force weakened, by the loſs of ſo much motion, deſtined for its ſupport.

L If A. M. fig. 1. be an elaſtic body not bended, and p. p. p. be primary atoms of the maſs, interſecting each other, ſo as to cohere; theſe atoms will have each its proper revolution about its own centre, returning always into the ſame orbit.

M Let A. M. fig. 2. be the ſame body bended, the atoms p. p. p. will then be flattened, and the atoms q. q. q. will be elongated. This change being preternatural, every atom̄ will tend to reaſſume its proper orbit, and this tendency will produce the ſpring of the body to unbend itſelf; and as it preſſes outwards, part of the revolving matter of each may penetrate the neighbouring atoms, as repreſented by the dotted lines; and thus getting out of its due circulation, and being in a manner *let looſe*, ſuch part of the revolving matter of the atoms may pervade the maſs, and become a current of ACTIVE SUBSTANCE flowing out, at either end, of the bended elaſtic body.

Inflammable bodies, by the acceſſion of fire, a ſubſtance highly active, acquire alſo that ſame active ſtate; but by thus in a manner letting looſe their activity, the ſtructure is damaged and deſtroyed, the revolving ſpheres which formed the atoms of the body are unfolded, at leaſt in part, and the ACTIVE SUBSTANCE of the body aſſumes a new form, more near to its priſtine ſtate. Accordingly, we find inflammable bodies wholly deſtroyed by combuſtion, and ſee them diſſipate in the form of more ſubtle elements. N

In chemical operations, and the proceſſes of living bodies, the inteſtine motions proceed from and ſerve to prove the reality of the conſtituent revolving motions, by which the bodies exiſt. As each atom exiſts and holds to other atoms by its revolving motion, it is eaſy to conceive that a great diverſity may obtain in their arrangement, and that they may have various relations among each other, and various affinities, whereby parts in union may ſecede, and new unions form, and different orders of parts compound and decompound; and hence ſolutions, precipitations, chryſtallizations, fermentations, evaporations, ſublimations; hence digeſtion, ſecretion, circulation, aſſimulation, and the various animal functions. O

P The revolving motions by which matter exiſts in *any form*, is a GENERAL BASIS for the internal powers, which, operating by *particular* and unknown laws, produce the various *changes of form*. The revolving motions afford a *phyſical power*, actually preſent in all bodies, and adequate to the productions of all their changes; it is only concerning its particular *laws of operating*, to produce thoſe changes, that we are yet ignorant (K 188).

Q There is a phyſical power which does not reſide in bodies, uſually denominated *gravity*; it is that whereby bodies fall, and are heavy. This power ſurrounds the earth, and it is probable, all the planets, to great diſtances. And ſince all phyſical power conſiſts in motion, motion muſt therefore ſurround the earth, and planets, to whatever diſtance gravity extends about them; ſuch are the ſpheres of activity above deſcribed (K 203).

R But this is a motion differently circumſtanced, in reſpect to us, from thoſe, which, by the revolutions of primary atoms, form bodies.

S An atom is a ſmall ſphere, the reſiſtence of which we diſcover from *without*, and on all ſides of the ſphere. The action which ſurrounds our earth, is a larger ſphere, *within* which we ourſelves are contained; and we can only, at any one time, and place, experience the reſiſtence in one certain direction, *i.e.* towards the centre.

Again, an atom is a ſphere of greater denſity, T which affords a more ſtrong reſiſtence; and the ſphere which ſurrounds the earth, a ſphere of leſs denſity, reſiſting leſs powerfully. An atom in an extenſion which is too ſmall to be perceived, reſiſts too powerfully for our ſtrength to overcome. The action of gravity, in a much larger extent, we can overcome, and in very ſmall extenſions it is not perceptible: we *feel* no weight in a very ſmall body, which yet may be ſo hard, that a man's ſtrength cannot break it.

Thus we find that nature contains within itſelf U all the powers neceſſary to her œconomy; and if it be true that power is neceſſary to a continued exiſtence of our being, in any form, that conſtituent power is to be regarded as the agent in thoſe changes of form, which all things, ſucceſſively, aſſume.

CHAP. II.

Origin of Motion.

A IF power originates from motion, it ſeems next in order to inquire from whence motion ariſes.

B We eaſily gather, from obſervation, that bodies do not begin to move from any cauſe within themſelves, and thence we are led to ſeek an external cauſe.

C We ſee that bodies are moved by the impulſe of other bodies, and hence we know impulſe to be an external cauſe of motion; an impelling body did not acquire motion from within itſelf, but from an external cauſe; and if this external cauſe were another impulſe, the cauſe of the motion of that laſt impelling body is to be ſought: and as ſucceſſive impulſes are not infinite, there is always a firſt impulſe, in every ſeries, which did not derive motion from impulſe, and conſequently it muſt have derived it from ſome *other* external cauſe.

That other external cauſe of motion, beſides D
impulſe, we are to inquire.

This cauſe cannot be body, ſince body is of E
itſelf quieſcent (B 222).

For this reaſon, obſervation cannot, in this F
reſearch, afford us any immediate aid, ſince only bodies are the ſubjects of our obſervation.

We muſt, therefore, proſecute the inquiry by G
the exerciſe of our intellect alone; obſervation can only aſſiſt us in a ſecondary way, by affording analogies, and other materials, to reaſon upon.

We are firſt to ſeek ſimple and intelligible H
cauſes, before we admit obſcure and myſtical ones.

We are to prefer a cauſe analogous to other I
known cauſes, before one which is different from the viſible order of nature.

The moſt natural and obvious analogy by K
which, in our preſent inquiry, we are to reaſon from

from facts *obſerved*, to the diſcovery of an *inviſible* cauſe, is that of *impulſe*.

L Impulſe is the only viſible cauſe of motion; an inviſible cauſe, which is in any way allied to impulſe, muſt be preferred before one wholly unconnected with it.

M It is from motion bodies derive their *impelling* power, and become, themſelves, cauſes of motion.

N The cauſe we now ſeek is not body (D 223), and therefore, in reſpect to its *ſubſtance*, has no apparent alliance with *impulſe*, which is performed by body: but ſince there are only two things neceſſary to an impelling power, viz. body, and the motion of the body; and the cauſe we now ſeek ought to be allied to impulſe, and is not in its *ſubſtance* allied to it, as body, it can only be allied to it in its *mode*, that is, in its *motion*.

O The inviſible and original cauſe of motion ought, therefore, to be a ſubſtance, motive, but not corporeal.

P Thus we arrive at the ſame principle, the ACTIVE SUBSTANCE, which to diſcover and underſtand, has been the main buſineſs of the preceding pages.

We are then led to conclude, that bodies which are moved, and not by impulſe, are moved by a motive ſubſtance, not corporeal. Q

If we were next diſpoſed to aſk, how this incorporeal ſubſtance moves bodies, we are ready again to ſtudy the *analogy* of the *ſenſible* cauſe. R

Bodies, in impulſe, act by their preſence contiguous with the body moved, and not by contiguity alone, but by *preſſure*, whereby the agent is diſpoſed to penetrate the patient, which in ſoft bodies it does, but in hard is reſiſted. S

So alſo the incorporeal agent ought to act by its preſence, contiguity, and *diſpoſition* to penetrate the patient; but being incorporeal, and incapable of being *reſiſted* by hard bodies, it ought alſo actually *to penetrate* all bodies that it meets in its courſe; and whereas *bodies* act by their diſpoſition to penetrate, *this* ought to act by its actual penetration. T

From the motive nature of this ſubſtance, and the perfect permeability of bodies to it, its ſucceſſive *flow* through ſeries of impelling bodies, and in all impulſe, is eaſily proved, as may be ſeen above (U 128). U

Hence,

X Hence, from the analogy of impulſe, we diſcover an inviſible original cauſe of motion, which ſerves reciprocally to throw a new light upon impulſe itſelf, from whoſe aid we were led to it.

Y For impulſe, although it is a *viſible* cauſe, is yet an *obſcure* cauſe of motion. All that we ſee of impulſe is the approach of the impelling body, its contact and its preſſure on the patient; we ſee motion in the patient follow theſe appearances, but an obſcurity ſtill pervades the fact; for all appearances, in impulſe, take place *without* the patient; motion, their effect, exiſts *within*; what, therefore, conjoins the *external cauſe* with the *internal effect?* Here the continuity of our ideas is interrupted, the chain is broken, a chaſm preſents itſelf, in which our minds are bewildered, without light or guide.

Z The continuity is reſtored, the link ſupplied, the chaſm filled up, a light and a guide are found, when, in impulſe, we trace the inviſible flow of the pervading ACTIVE SUBSTANCE, conveying from the vehicle *without*, the impelling body, to the new receptacle *within*, the newly moved body, an actual and efficient cauſe.

The ACTIVE INCORPOREAL SUBSTANCE, by its motion, is the origin of motion in bodies; what then the origin of motion in this incorporeal ſubſtance is, we muſt next inquire. A

We ſuppoſe that all beings, ſave the Supreme Cauſe, are the creatures and inſtruments of that cauſe. B

Every ſuch ſubordinate being muſt exiſt in a ſtate of motion or of reſt. C

But that which exiſts in reſt, can have no ſubordinate activity, cannot be an inſtrument of another; abſolute reſt is abſolute death, the privation of all power, all faculty, all inſtrumentality; it is pure and abſtract paſſivity, it can ſuffer agency, but exerciſe none[b], it can fill up no place in a chain of being, becauſe incapable of any agency, even in the loweſt degree ſubordinate. D

---

[b] In ſtrictneſs, abſolute reſt and inactivity cannot have exiſtence, and therefore cannot ſuffer agency, any more than exerciſe it. Exiſtence itſelf, implies activity; it is, therefore, only conditionally ſaid, that which exiſts at reſt (if any ſuch being does exiſt), can ſuffer activity, that is, if it can be conceived to exiſt, it can be conceived to ſuffer.

E If ſubordinate beings were created from nonentity, would the Creator have produced an *inactive lump of exiſtence*, as the immediate work of his hands? Could death have been the offſpring of the Parent of life?

[illegible] If inferior beings have exiſted always, and if any ſuch were always inert, from inertia, what activity could ariſe, what change, what ſucceſſion of exiſtence, from the negation of all faculty and all power?

G If the firſt origin of things, if Deity be an active cauſe, ſo, alſo, muſt ſecondary and inſtrumental origins be. If inertia can be an *immediate* agency, it may be a *remote*; if inertia can *act* in *any* degree, it can act in *every one*; either we muſt exclude *abſolute inactivity* from exiſtence, or allow of no other exiſtence; it can do nothing, or it can perform all.

H Whatever, therefore, be the elementary ſubſtance from which creation aſſumed its preſent form, whether, an incorporeal uncohering being, or whether, as is the prevailing idea, in this day, certain primitive bodies, ſmall and very hard; this elementary being, whether produced from nothing, by the creating fiat, or exiſting from eternity, *cannot be inactive, cannot have exiſted originally in a ſtate of reſt.*

If the elements of things were naturally at reſt, motion muſt be to them an unnatural ſtate, to which they muſt be repugnant. Nor can it be conceived how that to which reſt is natural, can exiſt in motion; or how the natural ſtate of a being can be deſtroyed without the being loſing its nature, and being itſelf deſtroyed. I

Since, then, reſt is not the natural ſtate of the elements of matter, their natural ſtate muſt be motion. K

The motion, therefore, of the elements of nature, originates only with their exiſtence, and is coeval with their birth. Motion is the primordial ſtate of creation, which it cannot loſe without ceaſing to be. L

Since then motion is a ſtate original and eſſential, reſt muſt be a condition derived, ſubſequent and accidental. M

And ſince all things that exiſt as derived, ſubſequent and accidental, muſt have been produced by thoſe which exiſt as original and eſſential; reſt muſt be the production of motion. N

There

O There are two relations of motion which produce reſt, equal concurring and equal contrary motions.

P In equal concurring motions, all the parts of the conſpiring motions are relatively to each other, at reſt; but the whole are in motion.

Q In equal contrary motions, the parts which move contrariwiſe, move relatively to each other, but the whole is at reſt.

R The reſt we experience on the earth's ſurface, in a carriage, or a veſſel in motion, is of the former kind, a relative reſt, among parts, of a whole in motion.

S The reſt of the ſolar ſyſtem, or of the univerſe, is of the latter kind; the motions of all the parts reſult in the reſt of the whole.

T I have not, in diſcourſing on motion and reſt, uſed the diſtinction generally adopted, of abſolute and relative motion and reſt; both becauſe it did not ſerve my purpoſe, and becauſe I am not ſatisfied of the propriety of thoſe diſtinctions. I rather apprehend that all motion is neceſſarily relative, and all reſt relative to motion; for motion being a change of place, and place being the relation between bodies compounded of diſtance and direction, that is, a relative thing, motion is only the change of relation between bodies. Reſt is the relation of equality and agreement in motions (P 230), or of their equality and contrariety (Q 230). In the one caſe, on *comparing* conſpiring motions, their *difference* is found to be nothing, in the other, on *ſumming up* contrary motions, the *reſult* is a cypher.

If, not conſidering the true nature of ſolid matter, we ſhould imagine it to be a pure inactive eſſence, void of motion, or tendency to motion, and impenetrable, it ſeems to me that no natural origin, or cauſe of motion, could ever poſſibly be aſſigned. For ſuch a cauſe muſt either act by its own motion, or by ſome other way. If it were ſuppoſed to act by its own motion, what being do we know that has motion in itſelf, or how ſhould we reaſonably ſuppoſe that one ſort of being, matter, was made without motion, and another ſort of being was made on purpoſe to give it motion that was not natural to it. But if we fancied a being made motive on purpoſe to move matter, we could not conceive how matter could be moved by it, or be moved, indeed, at all, if reſt was its proper nature. U

Matter

x Matter being impenetrable, nothing could be communicated to it, to ſuperadd a new nature, and nothing exiſting without it could be conceived to produce ſuch a change. If we ſuppoſe motion originated from ſomething not motion, this muſt be conſidered as a ſuppoſed miracle, and not a natural cauſe.

y Nor, as others have juſtly ſaid, can any uſe be conceived in nature for ſuch a being as matter, thus deſcribed. It could be only an incumbrance in creation; without thought, ſenſe, motion, or agency, it could exiſt to no end but to employ the active and intelligent powers of nature in the humiliating office of moving to and fro, inceſſantly, an uncouth, unyielding, unconſcious, and unanimated production, to which they could have no relation, and which all intelligent beings muſt regard as the opprobrium of exiſtence.

z But when matter, and reſt, are regarded as compound and relative beings, ariſing from immateriality and motion, into which they may, by decompoſition, again be reſolved; we no longer find, in the order of beings, that monſtrous incongruity—that infinite void between natures conjoined—thoſe oppoſite qualities in union—that univerſal death where only life is to be found—

thoſe inſuperable difficulties in the ſimpleſt facts—thoſe miracles in the ordinary courſe of nature, which the contrary hypotheſis creates; but we diſcover conſcious and unconſcious, material and immaterial, to be gradations in being, links of the ſame chain which embraces and unites the univerſe.

CHAP. III.

Origin of the Orbicular Motions, which the ACTIVE *or* ELEMENTARY SUBSTANCE *aſſumes, as the conſtructive Principle of Nature; and the Laws of the Elementary Subſtance.*

THE elements of creation, by exiſting in motion, exiſt in an active ſtate, and are fitted for performing a ſeries of ſubordinate agencies, and carrying on the œconomy of nature.

B But ſomething beſides motion was yet neceſſary to produce the forms of beings, ſuch as they are. Motion, in the original element, was a phyſical power, an agency *capable* of producing new forms of exiſtence; it was the active principle of creative life, the embryo of the future world. But it was *power* without direction, agency without order, activity to no end. Whatever exiſtences its unguided agitations produced, movements, equally capricious, would deſtroy: connection, order, and permanency, there could be none.

C To motion, in the elementary ſubſtance, it was neceſſary a LAW ſhould be ſuperadded; that its agency ſhould be guided to ſome regular purpoſe, and its motions conſpire to the production of uniform effects.

D Without ſuch a law, the elementary ſubſtance, left to movements altogether unguided and inconſtant, would make the chaotic ſtate, BEING "without form," that is, without any permanent form, connection, or order.

E And the impoſition of ſuch a law, by a GOVERNING INTELLIGENCE, would be a CREATIVE ACT; it would *give being* to a new ſtate of things, a NEW WORLD of order and beauty.

F We call that a law which determines the *manner* of exiſting proper to any being.

G That modification, therefore, which we have already ſhewn, obtains, in the active principle of nature, *motion about a centre*, may be called a *law of nature*, or a law of the ACTIVE SUBSTANCE; and it is a *general law*, becauſe it is that by which all material exiſtence is ſuſtained.

H But it is probable this is not a primary and arbitrary law, rather the reſult of ſome other, more ſimple.

I We may attempt the diſcovery of ſuch a law in two different ways; in one, it will ſerve only to afford a more general principle than has been hitherto obtained; in the other, it will, alſo, afford a *new proof* of the truth of what has been already propounded.

K If we aſſume the foregoing principles as true, and by inference from them, trace, upwards, the higher principles, in the ſame analytic method by which thoſe were inferred from more obvious truths; then the proof of the higher principles, we are now ſeeking, will reſt on the truth of thoſe prior ones aſſumed; and conſequently the foregoing principles can receive, in this way, no additional evidence, from the new ones, which are founded upon them only.

L But if we can, independent of any thing already ſaid, prove theſe higher principles by an appeal to new and diſtinct evidences, and then, from theſe higher principles, in the method of ſyntheſis, demonſtrate the LAW already deduced by the analytic method in the foregoing ſheets, this will be a NEW proof of that law of revolving motions (G 235), and of all the preceding ſeries of ratiocination, from which it was deduced.

M If both of theſe methods can be practiſed with equal certainty, ſuch concurring proofs, ariſing from diſtinct and independent ſources, will ſerve mutually to ſtrengthen each other.

N If we aſſume it as a fact, that revolving motions are a general law of nature, and we would infer from hence a law yet more general, in which *this*, of revolving motions, is imply'd; ſuch law is to be ſought as a RATIONAL CAUSE, and is by the firſt rule (A 102), to be that *which contains in it the nature and quantity of the effect.*

O The effect inveſtigated is a revolving motion about a centre; and the queſtion is, what law, or manner of being, in the ACTIVE SUBSTANCE, is implied in the motion of that ſubſtance, about a centre.

In anſwer to this we may obſerve, that whatever motions revolve into themſelves, or, circulating, return again to the ſame point, imply a *principle of union*, or a determination to unite. P

In this, circulating motions differ from thoſe Q which are merely progreſſive. The ſtream of a river, conſidered as iſſuing from its ſource, and terminating in the ſea, gives us no idea of union. The waters continually change; it is not the ſame river to-day that it was yeſterday; a part of the former has quitted its channel, its place is ſupplied by a freſh current: the mind ſees no permanent object, can embrace no durable whole; the river is always one river, but in no two moments is it the ſame; in any given number of diſtinguiſhable periods, ſo many different rivers exiſt.

This is not the caſe where motions circulate R into themſelves; here is no change in the entire whole; no parts ſecede, none are added. It is always the ſame, always one, in each, and in every ſucceſſive inſtant. Here we ſee a principle of union. It may be exemplified in the circulations of animals—of vegetables. In political bodies, a family, a ſtate there is a circulation of agencies and of benefits, the head gives vigour to the members, and in its turn is ſuſtained by them.

S Thus we find that *a principle of union* is implied in the revolving or circulating movements of the ACTIVE SUBSTANCE.

T But we may alſo aſſume *a priori* that a *principle of union* is a *general law* of nature, becauſe we ſee, in fact, all the component parts of the univerſe are united ſyſtems, which ſucceſſively combine into larger unions, and ultimately form *one* whole.

U From this principle, ſo unqueſtionable, we propoſe to demonſtrate the ſubordinate principle of revolving motions, which has, already, been inferred from phenomena.

X The ACTIVE ELEMENTARY SUBSTANCE exiſts in a ſtate of motion (N 106). If to this *motion* a principle or law of *union* be added, let us ſee what will follow.

Y We may regard the principle of union as operating in the ſmalleſt portions of the elementary ſubſtance, forming atoms, or in any larger component parts, or in the whole univerſe.

And we muſt diſtinguiſh two ſpecies of union, a more and a leſs perfect: the more perfect is that whereby units or wholes are formed, as atoms; the leſs perfect is that whereby a partial union connects theſe wholes, as in coheſion; and we here conſider union in its moſt perfect ſtate. Z

Let any portion of the elementary ſubſtance be given to form the moſt perfect union; and let a principle of union be ſuppoſed to begin to exiſt in ſuch portion, whoſe parts were, before, uncohering and independent of each other. A

The effect of ſuch a beginning principle would be a determination of all the parts of the given portion, already in motion, to approach mutually towards each other; and there muſt be, ſomewhere within the portion, a *centre of approach*, towards which all the parts, in common, tend; which centre will be at reſt, and void of any tendency, in any direction. B

But this determination of all the parts of the portion towards a *common centre of approach*, tends to the deſtruction both of the motion, and the exiſtence of the ſubſtance; for ſhould all the parts continually approximate, from a circumference, towards a centre, they muſt continually penetrate C each other, till the portion ceaſed to have any extenſion, motion, or exiſtence.

D Now to preſerve exiſtence, and, conſequently, motion, is the firſt law of the ACTIVE SUBSTANCE, as of all being. Union is a ſubſequent law. But the prior cannot give place to the ſubſequent; that which is eſſential, to that which is ſuperadded.

E Therefore all the parts of the portion of ACTIVE SUBSTANCE cannot continually obey their determination, induced by the law of union, towards each other, and towards a common centre of approach, becauſe ſuch an effect would be the deſtruction of the portion, and is therefore repugnant to a higher law than that of union, which diſpoſes to it.

F When the *direct* tendency of any inferior law is obviated by a higher law, the inferior law will operate *indirectly*, in the manner the neareſt to its direct tendency that the ſuperior law will permit. If a body in motion be obliquely obſtructed, it will move on in a direction oblique to its firſt motion, and not oppoſed to it. The laws of ſociety, when oppoſed to the higher law of ſelf-preſervation, are ſo far invalidated as that higher law requires; but the law of ſociety muſt be as nearly obſerved, as ſelf-preſervation permits.

G The ACTIVE SUBSTANCE cannot approach towards any point within itſelf, by reaſon of the law of ſelf-preſervation; but it will have a motion as nearly approaching to a concentrating motion, as conſiſts with the preſervation of its exiſtence.

H In the parts of any extended ſubſtance, a motion, which is conſidered as relative to a centre within the extenſion, muſt be a motion approaching towards that centre, receding from it, or revolving about it. Now the motions of the parts, cannot, as has been ſhown, concentrate; and they cannot retire from the centre, becauſe the parts have a determination to concentrate, and the law of ſelf-preſervation, which prevents their concentration, does not require that they ſhould recede; therefore, although they do not approach, they will not recede from the centre; conſequently, their motion can be no other than a revolving motion *about* the common centre of approach, *towards* which all the parts have a determination.

I We ſaid the parts of the portion of ACTIVE SUBSTANCE could not approach the centre, although diſpoſed to do ſo, by reaſon of a higher law, which regards the exiſtence of the portion, forbidding ſuch approach.

K But when, in conſequence of this higher law (D 240), which compels the parts that tend towards a common centre to deviate from that tendency, and follow each other, in a revolving motion *about* the centre this modification has actually taken place; it gives birth to a new tendency, that now ſuperſedes the operation of that firſt law of exiſtence.

L For we have ſeen that the direct influence of the *law of union* is to inſpire a tendency deſtructive of exiſtence (C 239); and while this tendency operates, and exiſtence is threatened by a poſterior and ſecondary law, the neceſſity whereby things *do exiſt*, muſt prevail, to obviate this *deſtructive tendency*; and muſt be conceived, in the firſt inſtance, actually to operate to this end.

M But when, from this operation, the *union tendencies* are converted into a revolving motion, a *new tendency* is produced, oppoſed to the *union tendencies*; and this *new tendency*, itſelf, ſufficiently obviates the *union tendencies*, prevents the parts from concentrating, and ſecures the portion from any danger of annihilation.

For it would ſeem, if not to endanger, at leaſt N to impeach the dignity of exiſtence, if it were expoſed to a continual attack, and if a ſecondary law of nature were eternally at war with a primary. It is, therefore, ſo ordered, that two ſecondary laws ſhall mutually counteract and balance againſt each other; that the danger which might ariſe from either, ſhall be obviated by the other, and the ſtate of things preſerved, without the continued exertion of the primary law of being, by a perpetual effort, to preſerve exiſtence.

It has been ſhown that motion is the original O and natural ſtate of the ACTIVE SUBSTANCE, and that this motion required to be governed by ſome law, in order to give being to an orderly and connected ſtate of things (c 234). Now there are motions ſimple and motions complex, but the more ſimple is, in all things, firſt in order, and out of the more ſimple the more complex ariſes, in order, poſterior. The moſt ſimple motion is rectilineal; therefore a rectilineal motion is to be conſidered as that which is the original and natural ſtate of things, and conſequently that *to which all things tend.*

It will follow, from hence, that when any P portion of ACTIVE SUBSTANCE in which the *law* *of union* operates, has, in the manner above explained (A 239, &c.), been compelled to aſſume a revolving motion, that is, a motion in ſome curve; a tendency to a rectilineal motion will continually exiſt, in every part of the revolving portion, and in every point of the curve which it deſcribes, during its revolution.

Q And this rectilineal tendency will be a tendency to recede from the centre in every point of the revolving orbit, and to proceed in a tangent to the orbit, at each point.

R This tendency to recede from the centre, ariſing from the rectilineal nature of motion, will be a tendency continually oppoſed to that other, which ariſes from the *law of union*, whereby the parts are diſpoſed to ſeek the centre.

S And theſe tendencies, to ſeek the centre, and to recede from it, being *contraries*, will, if they be alſo equal, deſtroy each other (E 103).

T And theſe will, in all caſes, at ſome time, arrive at an equality; for the tendency towards the centre, called the centripetal tendency, that is, the *law of union*, operating firſt, if we ſuppoſe the motion approaches the centre, the tendency to recede from it, called the centrifugal tendency, will have its proportion to the centripetal continually increaſed, as the orbit of revolution grows leſs, ſo as ultimately to equal the centripetal tendency, and reſtrain the motion from its central courſe, and at this point it will no longer ſeek the centre, but revolve about it.

Therefore, the revolution will be continued, U
without any tendency to the deſtruction of the portion, either by the annihilation of all parts in the centre, or by their diſſipation and waſte in the boundleſs extent; it will be preſerved by the EQUILIBRIUM of its own tendencies and laws.

It is in this part of philoſophy that mathematics X
come in with a timely and neceſſary aid to demonſtrate when the quantities of the two contrary tendencies are equal, and in what manner that equality ariſes out of the relation between curves and their tangents; and in all other caſes where quantities and relations of quantities are required it is the province of mathematics to ſupply the information ſought.

But this is not deſigned as a mathematical, but Y
a phyſical work; and to eſtabliſh juſt phyſical principles is neceſſary, before any utility can be drawn from mathematical ſkill. Men may enter deeply into abſtract ſpeculations, and reaſon with profound

profound genius from data aſſumed to the moſt ſublime efforts of the human mind; but if no phyſical exiſtences correſpond with thoſe data, no advantages can ariſe to the general ſtate of knowledge from exerciſes of this kind, and they muſt be regarded merely as *refined amuſements of the underſtanding*. To aſcertain, therefore, facts, and true phyſical principles, is our firſt concern.

Z And we have proved what was propoſed; that if to a ſubſtance, in its nature motive, but in its parts without alliance or connection, in its motions without guidance or order, a *law of union* be added, ſuch ſubſtance will begin to aſſume permanently revolving directions about quieſcent centres.

A But the original ſtate of the univerſe was that of an uncohering element; for, without doubt, parts muſt have exiſted prior to their coheſion; and have been extended, before extenſions were united; and it is certain, in fact, that the univerſe does exiſt ſubject to a law of union; and that law muſt have been impoſed anterior to the actual ſtate of union, that is, during the uncohering ſtate of the elements; therefore, under the conditions neceſſary to produce the revolving motions (z 246); conſequently, ſuch motions muſt be concluded actually to exiſt as the principle of union throughout nature.

And the proof is corroborated by the concurrence of two different methods in the ſame point. B
It hath firſt been demonſtrated by neceſſary inferences, carried upwards, from obvious *facts*, to their rational cauſes; afterwards it hath been deduced from a principle, higher, but more evident and ſimple, by conſequences traced downward, from the cauſe to its effects.

CHAP. IV.

The Mechaniſm of Coheſion, and the connecting Corpuſcles.

WHAT has been ſaid in the preceding chapter ſerves to afford ſome further inſight to the nature of coheſion, in addition to what has been already ſaid (G 175). A

We have there ſhown that atoms cohere immediately by a junction of their ſubſtances, and not B not by any myſtical or obſcure power, nor by any *intermedia* of a different nature, nor by hooks, linked together; and we have now a principle which may ſhow us the manner in which the junction of the ſubſtances of atoms may be effected.

C The principle collected from the reaſoning above, is this:

THAT THE OPERATION OF A LAW OF UNION, IMPOSED UPON A MOTIVE, BUT UNCOHERING SUBSTANCE, IS TO PRODUCE A QUIESCENT CENTRE OF MOTION WITHIN THE PORTION WHERE SUCH LAW PREVAILS, AND REVOLVING OR CIRCULATING MOTIONS OF THE SUBSTANCE ABOUT THAT QUIESCENT CENTRE.

D And theſe motions about a quieſcent centre conſtitute the revolving ſubſtance an united and reſiſting maſs.

E The *law of union* muſt have been ſuch as not only to conſtitute the univerſe *one* ſyſtem, but to give diſtinct unities to innumerable component parts. There is the moſt ſimple and primary union of atoms, there are intermediate unions of ſyſtems, of various orders, and there is an *ultimate* union of the whole. There are unions within unions, wheels within wheels.

When two atoms come in contact, or the boundaries of the revolving motions of each touch in any points, a diſpoſition to union may ariſe; that is, the law of union may operate between the ſubſtances of each atom. F

The operation of the law of union being, in all caſes, to cauſe the parts in which it operates to revolve about a quieſcent centre of motion (c 248), it follows, that if parts, reſpectively, of two atoms, by contiguity with each other, or by any other relations, become diſpoſed mutually to unite, a new centre of motion will be produced between the contiguous parts of the two corpuſcles, and the contiguous parts of each atom will revolve about this new, intermediate, and common centre. G

This new centre, and new revolution about it, will be a ſmaller and intermediate maſs or corpuſcle, compoſed of parts of the two corpuſcles which it ſerves to unite, and it may, from its origin and office, be called a *connecting corpuſcle*. H

In the formation of ſuch a connecting corpuſcle between two primary corpuſcles, when the revolving ſubſtance of each primary arrives at the part where the new centre, of the connecting corpuſcle is formed, it deviates a little from its I regular courſe, into the new orbit, revolving, at once, about its own proper centre, and the new centre formed between the two atoms.

K Let A. B. fig. 3, be two atoms approaching in or near contact with each other; and at the points of approach let the ſubſtance of each atom have, beſides its diſpoſition to union with the other parts of its own atom, a diſpoſition, alſo, to unite with the ſubſtance of its contiguous atom.

L Since parts, diſpoſed to union, tend to a centre, and revolve about that centre, forming, by that revolution, an united and reſiſting maſs (D 248), therefore the little maſs (M. fig. 3,) will be formed between the two atoms, out of parts of the ſubſtance of each atom conjoined.

M The maſs M. fig. 3, will, therefore, belong and be united to each atom A. and B. It will be itſelf an united maſs (U 182), laying hold of, and attached to A. and B. (M 177, A 183) and uniting them to each other.

N And although A. and B. are not united immediately to each other (Y 182), but through the medium of M. yet M. is itſelf an atom, and is united immediately, by interſection and combination of parts, to A. and B.

Although M. is called an atom, becauſe, like O
other atoms, it is formed by its own revolving motion, it is not a primary atom or corpuſcle, like A. and B. but ſtands in a peculiar relation to them.

M. has no ſeparate and independent exiſtence, P
but ſuppoſes the exiſtence of two prior atoms, each of which contributes its part to the formation of M.

M. alſo, is not formed by parts which revolve Q
ſolely and originally about its own centre, but by parts of A. and B. which, originally and primarily revolve about their own reſpective centres, and which, in the courſe of thoſe revolutions, by a deviation or aberration, in a certain part, deſcribe alſo the orbit of M. while they ſtill continue their own revolutions.

The ſubſtance, therefore, of M. is continu- R
ally changing, as all the parts of A. and B. near their circumference, paſs in ſucceſſion through M. Thus let d. e. f. fig. 4. be portions of A. revolving towards M. and g. h. i. portions of B. alſo revolving towards M.—theſe parts d. e. f.

and g. h. i. of A. and B. will, in ſucceſſion, arrive at M. and, revolving about its centre, become parts of M. till, in purſuing their courſe, they leave it, and new parts ſucceed.

S M. therefore, being formed of continually ſucceſſive portions of A. and B. has no proper being of its own, and may be fitly termed a CONNECTING CORPUSCLE or atom.

T An imperfect illuſtration of theſe may be had by conceiving two veſſels of water to be connected by an horizontal tube, through which the two bodies of water join. The water in the horizontal tube may repreſent the relation and office of the connecting corpuſcle, as it is formed out of the two bodies of water, and ſerves to connect them.

U In ſpeaking, before, of coheſion, we ſhowed that it muſt neceſſarily be produced by an intermixture of parts of the primary and moſt ſimple ſolids, becauſe the medium or uniting efficacy muſt have an union in itſelf, and the parts of this intermedium muſt lay hold of the parts of the atoms. But atoms are the moſt ſimple unions, and we ought not to deviſe a more complex union to connect the more ſimple; therefore there is no foreign intermedium between atoms, but they are united directly to each other; and ſince whatever unites two atoms, lays hold of the parts of each, two atoms, in cohering, do mutually interſect and lay hold on each other.

X We ſhowed that this could not happen with the impenetrable atoms of the moderns, nor could any rational mode of coheſion be deviſed for them; but that it was conſiſtent with the nature of atoms, conſidered as reſiſting only, but not impenetrable, that ſuch ſhould actually have portions intermingled.

Y And herein we avoided all myſtery, and all names of ambiguous import, and, equally, all hypotheſis and invention, adhering to the moſt ſimple facts, the moſt general analogy of appearances in nature, and the moſt eaſy conception of the mind, that if parts of two ſolids combine in any ſmall portions of their ſubſtances, the ſolids will adhere.

Z But ſtill, a difficulty remained to be ſurmounted; and this was, how the atoms which were primarily formed ſeparate and diſtinct ſolids, ſhould be brought, afterwards, to join together; for, it being admitted that it was the nature of an atom, although not to be impenetrable, to *reſiſt* penetration, ſome power or agency became requiſite in order that any ſmall contiguous portions of atoms ſhould penetrate each other, in the manner neceſſary to coheſion; and to have been compelled to ſeek a new cauſe for this ſole effect, would have been inconſiſtent with the ſimplicity of nature; nor do we know, in nature, where ſuch a cauſe could be found.

A But as, in the firſt part of this work, it was ſaid, that the coheſion, between two atoms, ought to be conſidered as an effect ſimilar to the coheſion between any two parts of the ſame atom; accordingly, it has now appeared that the very principle by which atoms are formed, ſerves alſo, equally, for their ſubſequent coheſion.

B And the difficulty above mentioned is removed, when a power already admitted to form the corpuſcles, and the law in which that power operates, ſerve alſo for their union, without introducing or ſuppoſing any new agency or new law whatever.

C The law of union, which, in diſtinct portions, produces the orbicular movements that become corpuſcles (c 248), operates, alſo, at the circumferences of the corpuſcles, between a part of one corpuſcle and a part of another.

And, as, in any portion, forming a ſingle atom, this law firſt tends to direct all the parts towards a common centre, and then to circumſcribe that centre (B 239, H 241), ſo alſo, in two atoms, the parts are, by the ſame law, directed firſt to a centre between them, and then circumſcribe that mean centre, which, thus, becomes the centre of union. D

The ſame phyſical power, the motion of the ACTIVE SUBSTANCE, and the ſame law of union given to that motion, firſt ſerves to *form*, then to *connect* the atoms. E

And herein I have, as I think, followed only the neceſſary deductions from ſelf-evident *data*; and with every part of this reaſoning, from the premiſes to the concluſion, facts and ſenſible evidences appear to me to concur. F

From the mode of coheſion here laid down, *varieties*, almoſt without end, may be diſtinguiſhed, abundantly adequate to the varieties found in nature in the genera and ſpecies of things. G

H And from the perpetual motion and activity, ſhown to exiſt in the interior of bodies, the chemical proceſſes of nature and art, vegetation and animal life, find their ſource. The changes which bodies undergo, ſpontaneouſly, or by admixture, gradually or ſuddenly; the commotions, agitations, and ſucceſſive forms of nature, are found to originate in the conſtitution and conſtruction of matter: but we leave theſe things to a future time, and challenge the aſſiſtance of others in cultivating ſo vaſt a country and ſo rich a ſoil.

One hint only I ſhall throw out, for the chemiſts. Since every ſingle atom is a little revolving ſphere, if two atoms only are joined to each other, by a connecting corpuſcle, both muſt revolve about their common centre, as the moon and earth are carried about their common centre by the revolving active ſpheres of each; and the ſmaller of two corpuſcles will be carried about the larger, or ſeveral ſmaller corpuſcles may be carried about one larger: and ſince, in fluids, the coheſion is leſs than in fixed bodies, and the corpuſcles are held together by leſs firm or leſs numerous attachments, this ſtate, of fluidity, is favourable to the various changes of decompoſition and union which happen in fluids with ſo much rapidity; and the inteſtine commotions

motions which appear during chemical proceſſes, may, moſt of them, ariſe from the looſe corpuſcles carrying, or being carried rapidly about the centres of others, according to their ſeveral relative dimenſions, denſities and other circumſtances; while fixed bodies, having their corpuſcles, on all ſides, mutually and more firmly connected, allow leſs of theſe inteſtine motions, each corpuſcle having ſo many and firm attachments, as to prevent it from being carried about the orbit of any one, or from changing its ſituation in the maſs to which it belongs: hence, chemical changes happen more ſlowly in fixed or ſolid bodies.

CHAP. V.

Of the Orbicular Motion of the ACTIVE SUBSTANCE *in Mechanical Impulſe.*

WHEN we ſpeak of the viſible motions of our own, or neighbouring bodies, we conſider the earth as being at reſt, and regard

only

only the local, relative, and tranſitory motions, with their local cauſes.

B These tranſitory motions, of which ſurrounding bodies are the ſubjects, we aſcribed to cauſes equally tranſitory; to an adventitious principle, of a motive nature, whoſe occaſional preſence moves the bodies, and whoſe exit leaves them quieſcent, as before.

C Thus we found a ſubſtance which freely pervades matter, and which, eſcaping from every body which impels another, enters the body impelled; and, in ſucceſſive impulſes, ſucceſſively tranſmigrating, as it continues to flow, till it ultimately arrives at its common reſervoir, the earth.

D In every impulſe, whether preſſure or percuſſion, the occaſional cauſe flows through the bodies concerned in the effect (B 130).

E Hitherto we have ſpoken only of impulſe in its moſt ſimple form, or of a ſingle impulſe, wherein one body is the agent alone, the other only the patient; one the tranſmitter, the other the recipient; and wherein the flowing ſubſtance paſſing through and out of a body, returns to it no more.

The ſame principle may now be applied to cafes of compound impulſe. If a body which ſuſtains another's preſſure, be alſo, itſelf, a preſſing body on that other, the principle of the flow of the ACTIVE SUBSTANCE becomes applicable to both; each is reciprocally agent and patient; each communicator and communicant. F

While the one, as an agent, is parting with its ACTIVE SUBSTANCE, it is, at the ſame time, as a patient, receiving that which iſſues from the other. G

The mutual preſſures being ſuppoſed *direct*, each body will now become the ſubject of two contrary currents of ACTIVE SUBSTANCE, each current impelling the body in the direction of its own flow. H

Conſequently, each body will, in mutual and direct preſſures, be at the ſame time impelled, or rendered active, in two contrary directions. I

If the preſſures, therefore the currents, therefore the activities, are equal in contrary directions, the body will be active ultimately in no direction (E 103), and will remain at reſt. K

L Agreeably to which the fact is, that bodies which preſs, and ſuſtain preſſure, equally, in contrary directions, are not moved thereby.

M Every current muſt have a ſource and a termination.

N In mutual and contrary preſſures the contrary currents have, reciprocally, the ſame ſource, and the ſame termination. For wherever the preſſure in one direction is conceived to begin, there it muſt be conceived, the current in that direction originates. And as in every part of one current, the contrary current counteracts and deſtroys its influence, the contrary current muſt proceed from its own ſource, to the ſource of the other, and there have its termination; and this reciprocally.

O If two contrary currents have, reciprocally, the ſame ſource and termination, that is, if the ſource of one be the termination of the other, reciprocally, the two currents, with their ſources and terminations, form together one circulatory ſyſtem, revolving into itſelf, and thereby conſtituting the ſeveral parts one entire whole.

P Therefore, in all contrary impulſes, however tranſitory, a circulatory motion of the ACTIVE SUBSTANCE, revolving into itſelf, is produced.

Such a motion has been ſhown to be the con- Q
ſtructive principle of matter and of the world. If, therefore, the ſame principle by which the permanent appearances of nature are produced, obtains and operates in the accidental occurrences of contrary preſſures, there ought to be found a perfect analogy between thoſe permanent and theſe accidental effects, which depend thus on ſimilar cauſes.

And this analogy is actually found. R

For the operation of the orbicular motion in S
atoms, or in the larger ſpheres (D 248), is to produce an UNION among parts, otherwiſe diſtinct. An atom conſiſts of parts, which, independent of their motion, are uncohering, and diviſible, without end; but, by their orbicular motion, they together conſtitute one undivided atom.

In like manner, two bodies, reciprocally preſ- T
ſing on each other, and thereby, as has been ſhown, *being contained within the courſe of one circulatory ſyſtem,* or revolving motion (O 260), become

come abſolutely one maſs, ſo long as the preſſure continues.

U For, to have parts held together is the characteriſtic of unity. If *two* ſemi globes be attached together at their baſes, they become *one* globe. It is by various ſorts of attachment, that *ſeveral* parts are made to form *one* object, a building, a machine.

X Mutual preſſure attaches bodies together; while the preſſure ſubſiſts, they cohere, are held to each other, they are conjointly moved or at reſt, they are inſeparable, unleſs a force is employed greater than that which holds them together, and which, in all caſes, diſſolves unions. The union is, therefore, perfect between two bodies which mutually preſs and are preſſed.

Y The analogy is therefore perfect between any ſuch tranſitory preſſure, and the more permanent effects of nature.

Z As from the ſimilarity of the principles, operating in theſe different caſes, we *inferred* the analogy which does in *fact* appear; ſo from the analogy, in itſelf obvious, we might, with equal certainty, have inferred, by a contrary method, the ſimilarity of the operative principles.

The ſcene now expands upon our view; we have traverſed from the primordial parts, to the limits of the world, and found nature, amidſt all her infinite diverſities, ſtill uniform. We are now able to add to this catalogue innumerable, intermediate, local, and tranſitory appearances; among which are all the effects of art, wherein action is mutually ſuſtained and exerted: in all of theſe the active principle performs that circulatory flow by which every union is produced and ſuſtained.

CHAP. VI.

Abſurdity implied in the Queſtion concerning the Origin of Motion.

THE queſtion, whence is the origin of motion, ſuppoſes that reſt was the primitive ſtate of matter, and that motion was produced by a ſubſequent act. But this ſuppoſition muſt ever be rejected, as it is giving precedency to the inferior, and inverting the order of nature.

What

B What life is to death, motion is to reſt. Was death, then, the firſt act of creation, and did life ariſe from that death? Was death the immediate offspring of Deity, and life produced in a ſecond generation? Or had death exiſtence from eternity, and, in time, did life iſſue from its womb?

C If the firſt creation were reſt, the ſubſequent act, that produced motion, deſtroyed the reſt, which was firſt born; or if reſt were eternal, that eternal ceaſed to be, when motion came into exiſtence. But wherefore did the Creator produce, what by a ſecond production he muſt deſtroy? or how could non-entity annihilate its eternal rival, and ſtart into its vacant throne of being?

D But to ſuppoſe reſt prior, and motion ſubſequent, involves all theſe incongruities, and the queſtion which implies this ſuppoſition, is, therefore, founded on a fundamental error, and ought, in the firſt inſtance, to be rejected.

E Our ſenſes ſtill deceive us, and notwithſtanding the high rank experimental ſcience now holds, and the infallibility aſcribed by ſome to the teſtimony of our *nerves*, it has ever been the office of reaſon to correct the errors into which an implicit confidence upon their report precipitates us; and this, our intelligent guide, finds her labours multiplied before her by the well-meant endeavours of many, in the preſent day, to diſpenſe with her aid.

F The apparent reſt of bodies around us we miſtake for real, and then inquire whence the motion is derived that we perceive to ſucceed that reſt. But all thoſe bodies, which appear at reſt, are already in motion; and thoſe motions which to us ſeem begun, and ſucceeding to reſt, are no other than certain tranſitory inequalities, which ariſe from local cauſes in the diſtribution of the general current of motion, by which all bodies are inceſſantly carried along, excepting ſuch irregularities, with an uniform flow.

G We miſtake the world for a ſtagnant lake, in which, while we appear to float at reſt, we inquire from what cauſe neighbouring bodies occaſionally move.

H But we are, altogether, floating along a current which is imperceptible, becauſe we are carried with it, and no banks enable us to diſtinguiſh its flow: while all things in view move uniformly along all ſeem at reſt; but if, here and there, one of the floating bodies is hurried on before, or detained behind its companions, this inequality gives the appearance of a motion begun, and we demand its ſource, ſince all around is reſt. But if we knew or recollected that, in fact, all is motion around us, we then ſhould not inquire, in any one body, the ſource of a motion which it has in common with others, but the ſource, only, of ſome increaſe or decreaſe of motion which diſtinguiſhes it from its neighbours. When a body, as we ſay, is moved, it is not *then moved*, but only ſuffers a change of the motion it before had, by communication with local cauſes which render the general diſtribution unequal.

It was the apparent reſt of bodies, and the appearances of beginning motions, that firſt led men to ſeek their origin, as thinking it an accidental mode of being, ſubſequent to the exiſtence of matter: and though the ground of this inquiry was deſtroyed, when the motion of the earth was diſcovered, yet the ſpirit remained; for ſtill the earth was ſuppoſed to have exiſted once at reſt, and the queſtion of the origin of motion was transferred to it, placing the inquiry on a worſe footing than before. Men were, perhaps, cautious of bringing in the direct agency of the Deity, to move ſmaller bodies, but when the earth and planets were in queſtion, they thought the bulks and the velocities of theſe bodies were the effects of a power not unworthy an Almighty arm; and principles, admitted, depriving them of any other cauſe, philoſophers ſcrupled not to introduce the Creator in the world already formed, launching forward, by a mighty impulſe, the planetary orbs, in their ſeveral ſpheres. A magnificent thought for the heathen mythology; worthy the arm that ſubdued the Titans, or that which, by one ſtroke, could open the ponderous earth to its very centre; but infinitely unworthy that INTELLIGENCE from which the univerſe aroſe.

The incongruities which attend the queſtion, K how motion began, are not retained, if motion be conceived as original, and reſt as its production; for although, if reſt were original, motion would imply its deſtruction, yet if motion be primary, the reſt which ſucceeds, does not imply the deſtruction of the motion, it being only certain relations of the motion agreeing with it and produced by it (o 230). Nothing, then, once created, is deſtroyed; and motion, as it is more excellent, is precedent to reſt. Further, if reſt be the firſt quality of things, it muſt be an abſolute reſt—an entire reſt—a negation of motion—an eſſential death: but if reſt be only a production of motion, it is then only a relative reſt, ſuited to the nature of a living world, and ſuch a reſt as alone does, in fact, exiſt.

CHAP. VII.

Law of Union, in what Reſpects agreeing with the Attraction of the Newtonian Philoſophy, and wherein diſtinguiſhed from it.

A THE law of union, above ſpoken of, has in ſo much, an affinity with the modern attraction, as to render a comparative view of theſe two principles expedient.

B Attraction is a name given to a tendency to approach each other with which all bodies are ſaid to be endowed, in the direct proportion of their maſſes, and inverſely in the ratio of the ſquares of their diſtances.

C The law of union, of theſe pages, ſaid to exiſt, not in matter, but in the elementary principle of matter, is a tendency, in certain parts, and portions, to approach each other; but in what ratio to the magnitude and diſtance, has not yet been ſaid.

D These two principles agree, in that both aſſert a principle of union to exiſt in nature, and a diſpoſition to approach, to be given to diſtant beings, by a governing power.

E They differ in that one ſuppoſes this principle to be impoſed immediately upon matter; the other ſhows the principle of union to be given to an immaterial and primary element. Let us inquire to what this difference leads.

F The principle of attraction is employed to explain the motions of the celeſtial bodies. In order to this, it ſuppoſes, beſides the attraction, two things, firſt, an impulſe given to theſe bodies; ſecondly, an innate principle in the bodies continuing the tendency, the impulſe imparted, towards a rectilineal motion. The attraction, as a third force, is employed to draw the bodies from their rectilineal direction towards a centre, and from the balance between the centrifugal and centripetal tendencies, their revolutions are found to reſult.

Although

G Although this reſult be granted to flow from theſe things ſuppoſed, yet the ſuppoſitions are inadmiſſible, partly as being hypothetical, partly as being inconſiſtent with themſelves, or with other principles received. An impulſe miraculouſly given to the planets after they were created, is merely hypothetical; an innate principle of motion in the bodies, whereby they continue to move after the impulſe, is inconſiſtent with itſelf; for the neceſſity of an impulſe to move the bodies, ſuppoſes them not to have any innate principle of motion. A tendency of bodies to approach each other, is inconſiſtent with another principle received, namely, that bodies are inactive; for, if inactive, they can have no tendencies, nor can act upon each other.

H The law of union ſerves to a much more extenſive purpoſe than the attraction of bodies, while it is neither hypothetical, nor incongruous. Attraction preſuppoſes the exiſtence of matter, the law of union explains its formation.

I The law of union is a tendency ſaid to be imparted to a ſubſtance already active, and endowed with tendencies; it therefore implies no contradiction.

It enables us to explain the motion of bodies without ſuppoſing a preternatural and miraculous impulſe given to the planets, an event merely imaginary, ſolitary, unparalleled in nature, and inadmiſſible ; and alſo without requiring that other principle in bodies, in itſelf ſo contradictory and incomprehenſible, the *vis inertiæ*, ſaid to be indifferent to motion or reſt. K

From the law of union alone, exiſting in the ACTIVE SUBSTANCE, all thoſe conſequences reſult, to which attraction is inſufficient without two other concurring hypotheſes : it ſerves alſo to much more extenſive purpoſes ; it is more intelligible, more ſimple, and more uſeful. L

If it be ſaid that, nevertheleſs, the law of union is the ſame thing with an attraction, if applied to the parts of the ACTIVE SUBSTANCE, I reply, that I think the term attraction, however it may be defined, exceptionable from its etymology and its general acceptation, becauſe it implies not merely a tendency between two diſtant beings to approach, but rather an agency between them, mutually exerted on each other, by pulling or drawing. But ſince, when I ſay that parts of the ACTIVE SUBSTANCE actually tend to unite, I do not mean to aſſert that one part draws M or pulls another; I think it important to lay aſide the term attraction, as being liable to miſinterpretation, and having been, in fact, a ſource of much error.

N I have hitherto termed the active element of the world the ACTIVE SUBSTANCE, by this denomination to diſtinguiſh it from matter, which is an inactive ſubſtance; and have avoided even terming it a fluid, leſt this term might convey ſome idea of materiality. It is, however, the original and moſt perfect fluid, without being material, ſince it poſſeſſes eſſentially, that requiſite, a facility of motion among its own parts, which gives an imperfect fluidity to matter.

PART IV.

Some Abridgements of the foregoing Ideas; their Agreement with Facts: Concluſion.

CHAP. I.

Conſtitution of the Univerſe.

THE original ſtate of the univerſe is that of a moſt ſubtle and perfect fluid (N 272). A

This fluid is not formed of parts, each, in itſelf, a ſolid, and becoming fluid, in an aggregate maſs, by their want of attachments, and by their ſmooth ſurfaces admitting of a free motion among each other; but it conſiſts of homogeneous parts, every where unſolid, and devoid of attachment; the ſmalleſt portions being fluid equally with the larger, and with equal facility admitting of motions among each other, or each within itſelf.

B Motion is an eſſential property of this primitive fluid.

C The motion of the primitive fluid is a force, agency, or phyſical power.

For by force, agency, or power, is ſignified whatever can produce a change, or a tendency to change; now a fluid, to which motion or change is eſſential, can, by union with other beings, induce on them its own changes or diſpoſitions thereto.

D This moſt perfect fluid, whoſe parts are no where held together, cemented, or attached quieſcently to each other, is, by its motion, formed into ſolid exiſtence, with parts united, firſt, within themſelves, and ſubſequently to each other.

E The motion whereby the primitive fluid is conſtituted a ſolid, is an orbicular motion, or a progreſſion revolving into itſelf.

For all thoſe parts, otherwiſe diſunited, which continually revolve in the ſame orbit, about the ſame centre, are united in that orbit, and by that centre; they preſerve the ſame diſtances and relations, and conſtitute one whole. The parts of that whole are forcibly held together by their determination to continue in the ſame orbit; and the whole, ſo formed, is a ſolid or cohering maſs.

The ſolid, thus produced by the rotation of a F
portion of the primitive fluid about a centre within the portion, is at reſt, excepting only, whatever motions it may have, induced by external cauſes.

If two ſuch ſolid ſpheres interſect each other, G
or are each interſected by a third, they will hold together, or cohere.

The univerſe is a congeries of ſuch ſolids, of H
different denſities and magnitudes, of which ſome are held together by interſection, others, ſmaller, are contained within larger, in ſeveral ſucceſſive gradations.

The orb of the ſolar ſyſtem is the largeſt ſolid I
with which we are acquainted; each of the fixed ſtars have ſimilar ſurrounding orbs; and theſe

orbs, by mutual interſection, cohere together, forming, by this means, the quieſcent maſs of our univerſe.

K Within the orb of the ſolar ſyſtem are contained ſeveral ſmaller ſolids, to wit, the planets primary and ſecondary, which are found, by obſervation, to revolve about the ſun, and, together with it, about a common centre.

L These ſolid bodies being contained within the orb of the larger ſolid, the extenſion of the ſolar ſphere of activity, muſt neceſſarily be carried about the centre of that larger orb, by its revolving motion, at the ſeveral diſtances wherein they are placed.

M Beſides, the bodies of the planets, there are leſs denſe ſolids, which encompaſs their more firm maſſes to a certain diſtance. The atmoſpheres of the planets are larger ſolids, encloſing the planets, as nuclei; but ſtill larger, are the active ſpheres of the primitive fluid, which envelop each planet.

N Several of the planets, beſides being involved and carried round in the ſphere of the ſun's activity, have their own particular attachments. Smaller planets have their active ſpheres attached to the active ſpheres of larger, and, by the larger active ſpheres, are carried about the larger bodies, at the ſame time that they accompany the progreſs of theſe larger, about the ſun. Such are the ſeveral ſecondary planets.

The active ſpheres of any planet, of the ſun, or of any fixed ſtar, are, each, *ſingle ſolids*, attached to others. O

The body of the earth is a maſs, or *congeries* of ſmaller ſolids, attached together. P

Of theſe, two kinds are united in different ways. Q

Firſt, there are looſe or uncohering bodies, animals, ſtones, fluids, &c. moveable on the earth's ſurface, but held and tending to the earth, and if forced from its ſurface, returning to it when left to themſelves. Theſe looſe bodies are, by the action of the external ſphere, confined in one maſs, making the globe of earth, which is a central nucleus to that external ſolid, or circumſcribing active ſphere. This tendency of all parts of the earth to its centre, is denominated weight, or gravity, and is commonly explained by a ſuppoſed mutual influence between all parts of the earth, whereby the general R ral maſs detains each particular body, or draws it back, if by any means it has been removed; in fine, by a law of union impoſed on all matter. But matter being a ſolid, formed by ſuch a motion of the primitive fluid as renders the ſolid inactive, is incapable of receiving any law of union, becauſe ſuch a law implies activity. Matter, therefore, can only receive activity in a ſecondary way, as ſuperadded by the primitive and active fluid, and acquiring ſuch tendency, motion, and direction, only, as this fluid imparts, itſelf being a pure, *unreſiſting* paſſivity.

S *Secondly*, beſides this attachment from without, by which all parts of the earth, however unconnected in themſelves, are compreſſed together, by a ſurrounding fluid, there are immediate and internal attachments of parts to parts, which exiſt independent of that extraneous force.

T These are the coheſions among the ſmaller and primitive ſolid ſpheres or atoms by mutual interſections, which preſerve the maſſes of ſenſible bodies, in the various forms which art and nature preſent to us.

U There are two ſorts of primitive ſolids; the primary atoms, and the larger ſpheres of the univerſe. Theſe reſemble each other in their laws and conſtruction, differing only in magnitude and in denſity.

There are two ſorts of maſſes conſtituted by X the interſection or coheſion of theſe ſpheres, ſenſible bodies, and the maſs of the viſible univerſe formed by the coheſion of the ſtarry ſpheres.

The ſmaller maſſes, of ſenſible bodies, formed Y by the attachments of the ſmaller ſpheres being contained within the larger order of primitive ſpheres, are, by the law of union of thoſe ſpheres, driven each to its own centre, and acquire a new union, to wit, of gravity, by the ſuperincumbent and ſurrounding influence of the larger primitive ſpheres. The ſmaller ſpheres, or atoms, and the maſſes they form, being all thus driven to the centre of their reſpective larger and containing ſpheres, form the globes of the ſtars, ſun, and planets, each in the centre of its own ſphere.

The ſubtle revolving fluid, the centre of whoſe Z vortex the earth occupies, not only ſurrounds, but pervades the earth, and other vortices their earths, to their centres; and the earth and planets are, by its revolutions, carried around on their own axes.

A The earth is an inactive maſs, and all its component maſſes are ſeverally, as collectively, inactive; but the earth, and all its parts, have various collective and ſeparate movements, imparted from the fluid which ſurrounds, pervades, and conſtitutes it.

B Being immerſed, together with its proper ſurrounding ſphere, in the larger ſphere of the ſun, it is carried thereby, in a large orbit, about the ſun.

C At the ſame time, by the revolution of its proper ſphere, it rotates on its own axis.

D Theſe two motions belong to the whole globe, and by theſe, the component parts, at equal diſtances from the centres of motion, have equable velocities.

E Beſides theſe, parts of the earth have various relative motions among each other, ſuch as currents of air and water, earthquakes, the ordinary phenomena of animal and vegetable life; of mechanical or chemical changes; which occur to daily obſervation.

F The globe of earth is immerſed in two diſtinct oceans of the pervading fluid; its own proper ſphere, and that of the ſun. Beſides theſe, it conſiſts of the ſame fluid, modified, by revolving in ſmaller ſpheres, into the primitive material atoms.

By certain relative circumſtances, the active G fluids, which pervade the earth, may be determined to ſome local irregularities, ſo as to impart to certain bodies, more or leſs than their common proportion of activity.

The primary atoms are formed inactive by H the orbicular motion of the active fluid about a centre, that is, in a manner, by the folding up of the active fluid, into itſelf. If, by any proceſſes, or mutual agencies, any of theſe loſe their orbicular motion, and are unfolded, ſo that the fluid, inſtead of revolving in the ſmall orbit of the atom, ſhall move progreſſively onwards, the atom is then *reſolved* into the primitive fluid; and the portion of fluid which ſerved to form the atom, now reſumes its original active ſtate, and becomes a motive agent to other atoms or maſſes of matter with which it may unite.

It is probable ſuch an unfolding or decompoſi- I tion of the primitive atoms takes place in nature, and that herein are found the origin of many natural agencies; namely, in matter, itſelf, reſtored to its priſtine active ſtate; and that from theſe, and from the cauſes above mentioned (G 281), all the apparent motions of bodies upon the earth, all changes, proceſſes, and productions, are to be derived.

K When, from either of theſe ſources (G, H 281) any atom or maſs becomes impregnated with more than its common proportion of the active fluid, or with portions of the active fluid directed differently from their ordinary courſe; or any portions, by communication with others, loſe part of their common proportion; ſuch atom or maſs, which before had a relative reſt among its neighbours, will now have an *extraordinary*, and thence an *apparent* motion; and ſome change will thence be produced in the ſenſible appearances of bodies.

L And in this way do the various phenomena of nature and art occur, to wit, by relative motions of parts among parts, induced by ſome local changes in the equable diſtribution of the conſtituent or pervading fluid (D 113).

M A more particular explication of phenomena by ſhowing their correſpondence with various relative circumſtances of this fluid, will belong to a future work.

CHAP. II.

Agreement of Phenomena with the Theory.

IF the theory laid down be true, propoſitions of facts, deduced from it, will agree with appearances in nature; and this agreement will ſerve eſpecially to confirm the doctrine, becauſe the principles were not gathered, ſubſequently, from experiments, and fitted to them, but have been drawn from independent ſources, purely intellectual. A

A BODY BEING AT REST, WILL, OF ITSELF, NEVER BEGIN TO MOVE. B

Becauſe, being inactive, it contains, in itſelf, no cauſe of motion or motive tendency.

OBSERVATION I.

A body is never found to begin to move without the acceſſion, to it, of ſome external cauſe. C

DEFINITION.

Reſiſtence is an action conſidered in its relation of oppoſition to another action. D

E A BODY AT REST WILL NOT RESIST ANY ACTION OR FORCE EMPLOYED TO MOVE IT.

Becauſe, being inactive, it is incapable of reſiſting, which is acting.

OBSERVATION II.

A body at reſt, ſuſtaining any motive agency, acquires a motion or motive agency, equal to what it ſuſtains, the external obſtacles of friction and *media* being taken out of the account.

F This fact is univerſal and agreed upon. Friction and mediums diminiſh or deſtroy a part of the motion, which, otherwiſe, the body would acquire from the influence exerted on it: theſe, then, are truly reſiſtences, or contrary actions: but abſtracting theſe, or, if there be no ſuch reſiſtences, the whole influence exerted, is found in the body. This could not be the caſe, if the body reſiſted: if it reſiſted, ſo much as it reſiſted, it would, like the afore-mentioned reſiſtences, diminiſh motion, and the reſiſtence of the body ought to be, always, a quantity, either by itſelf, or in addition to the other reſiſtences, the meaſure by which the loſs of motion ſhould be determined. But the loſs of motion follows the proportion, only, of the other reſiſtences, friction, and *media*; and if there be no friction nor medium, there is no loſs of motion; conſequently, the body does exert no reſiſtence, nor is there *any* reſiſtence beſides thoſe already mentioned. In the falling of a heavy body, the body acquires all the momentum, which, from its weight, and the time of its deſcent, it ought to poſſeſs, excepting ſo much as muſt be taken away, on account of the known reſiſtence of the air.

OBSERVATION III.

If a heavy body be ſuſpended by a ſtring, G
and the ſtring be cut, the body will deſcend.

As in this example there are not the circum- H
ſtances of loſs of motion by communication, and the ſhock attending impulſe, the fact is more ſimple and concluſive; the motive influence is inviſibly, ſilently but continually exerted, and the body, although at reſt, conſtantly tends to move. The ſeparation of the cord which ſupports it, is not an action upon the body, it is only the removal of the contrary action by which it was held in equilibrio: if the quieſcent body, when its ſupport was removed, *reſiſted* the influence which determines it to fall, this reſiſtence muſt be in ſome way manifeſt, and muſt impede the fall proportionally to ſuch reſiſtence, at the very commencement of the motion; but ſince no ſuch impediment appears, the fact demon-

ſtrates, that no reſiſtence whatever is exerted by the body.

I IF THE FORCE EMPLOYED TO MOVE A BODY AT REST BE AN IMPULSE, THE IMPELLING BODY WILL LOSE AS MUCH MOTION AS THE OTHER ACQUIRES; ABSTRACTION BEING ALWAYS MADE OF THE RESISTENCES OF MEDIUMS AND OF FRICTION.

The impelling body being actuated by an adventitious fluid, which, in the impulſe it communicates to the body impelled, muſt itſelf have ſo much motion or activity leſs, as it has parted from to the other (R 127).

OBSERVATION IV.

K Let a body, at reſt, ſuſpended freely, and inelaſtic, be ſtruck by another inelaſtic body, of an equal maſs, both bodies will proceed together with half the velocity of the impelling body.

L The impelling body, after the ſhock, having only half of its former velocity, hath loſt half its motion, and the other hath gained an equal quantity; its motion from a ſtate of reſt, being, after the ſhock, equal to what the impelling body hath loſt.

The diminution of motion in an impelling body has been attributed to reſiſtence in the body at reſt, but, on *any principle*, this is inconſiſtent with the *fact*; for, if a body in motion, agreeable to the received theory, moved and impelled by an *innate power*, and it was *reſiſted* by a body at reſt, the impelling body would be impeded by the reſiſtence, but the body at reſt would not be moved for two reaſons; *firſt*, becauſe it could receive from the other none of its innate power, by which it had impelled; *ſecondly*, becauſe that power of the impelling body, which is reſiſted, cannot produce its effect, at the ſame time that it is reſiſted; but the body at reſt receives power from the other, therefore the power is not innate, and the power of the impelling body has its full effect, therefore is not reſiſted. The diminiſhed motion of the body which impels, is an effect of its having parted with its motive influence: it is ſo much diminution, in conſequence of ſo much deprivation. M

As the body at reſt *cannot* reſiſt becauſe it is *inactive*, ſo the body which loſes its motion, does not *require* to be reſiſted, becauſe it has loſt its diſpoſition to move, at the ſame time that it has loſt its motion. The ſupport of this doctrine of *reſiſtence in a body at reſt*, lays in a miſuſe and equivocation of terms. N

Bodies

O Bodies are ſaid to be inactive, and to reſiſt by their inactivity. Reſiſtence, therefore, is here uſed in a ſenſe ſeemingly contrary to ours; it is not an action, but belongs to inactivity. So abſurd a thing as reſiſtence without action might ſhock our reaſon; but this abſurdity is apparent, not real; the uſe of terms only is reverſed, inactivity means activity. The inactivity of body, and the reſiſtence of inactivity, are in truth the activity of body, and the reſiſtence of activity; for this inactivity is ſaid to *be exerted, to perſevere, to impel, to react, to produce change in other bodies, to be a power or force*, and all theſe, more or leſs, proportionally *to the body whoſe force it is*. If theſe are not active qualities, I beg to know what are? If inactivity be ſaid to perform and be all theſe, what is the difference between it and activity?

P Such is the manner in which this term *inactivity* is perverted and abuſed to anſwer the purpoſes of an hypotheſis.

Q Definitions are the baſis of all demonſtration: the terms activity and inactivity are not defined in the received ſyſtem, but they are confounded together.

This

R This play, on terms, may again be obſerved, in the method of proving, that a body in motion, perſeveres in motion by its inactivity. For, it is ſaid, that it requires an action, to ſtop a body in motion; and ſince a body in motion, is inactive, it cannot exert an action to ſtop itſelf; it muſt, therefore, go on to move for want of action to ſtop itſelf, that is, by inactivity. There is an inconſiſtency throughout this argument. A body in motion requires an action to ſtop it, this is evident; but, is this a proof that it is inactive? On the contrary, ſurely, it is a proof of its activity, while in motion. An action is required to ſtop it; but, it cannot be expected, that the ſame activity, which moves the body, ſhould alſo ſtop it. The body goes on, not for want of activity, or by inactivity; but becauſe its activity diſpoſes it to move, and not to ſtop.

S A BODY AT REST, BEING IMPELLED BY A MOVING BODY, RESISTS THE BODY WHICH IMPELS; ALTHOUGH IT RESISTS NOT THE FORCE OF THE IMPULSE.

T This is a very important diſtinction, between reſiſting the *maſs* of a body, and reſiſting its *motive* force: and we ſhall find it correſpond throughout, both with theory, and with fact.

U All reſiſtence is action, and ſuppoſes another action, reſiſted. It is denied, that a quieſcent maſs reſiſts the motive force of another maſs impelling, becauſe the quieſcent maſs is inactive, and the force being tranſlated only, is not, in fact, reſiſted. But, if a quieſcent maſs reſiſt the maſs and not the motive force of an impelling body, there ought to be an action in the quieſcent maſs; and, in the motive one, an action diſtinct, from that by which it is motive; ſuch, in fact, are the conſtituent activities (D 113), or coheſive powers of every body. Theſe actions are alike in a body, whether it be at reſt, or in motion. They preſerve the forms of bodies, and hold their parts together. In impulſe of a motive, on a quieſcent body, the motive body, endeavouring to continue its motion, becomes a force, whereby the cohering maſs tends to penetrate the quieſcent body, and this tendency is an action on the coheſive force; the coheſive force reſiſts, and by this reſiſtence, acts alſo on the impelling maſs to penetrate it. Theſe are actions and reſiſtences of the conſtituent, or coheſive activities, and have no effect on the motive activities, or the motion of the maſſes.

OBSERVATION V.

X A maſs in motion, has its velocity diminiſhed, by impulſe on a quieſcent body.

Reſiſtence is an action, which impedes, or obſtructs the effects of another. The retardation of a body, is an evidence that the body has been reſiſted, as the communication of motion ſhows that the action has not. Y

A BODY ACTED ON WHEN AT REST, DOES NOT RE-ACT. Z

Becauſe it is inactive; nor can action proceed from reſt.

Observation VI.

If a body at reſt receives an impulſe, it acquires ſo much motion as the impelling body loſes. A

Explanation.

If the body at reſt re-acted, it would deſtroy the force of ſo much of the impulſe, as was equal to the action, while the re-action would alſo be deſtroyed, in the manner that contrary actions oppoſed, always deſtroy each other; and, conſequently, if the re-action were equal to the action, both would be deſtroyed; but as there is no deſtruction of action, merely a tranſlation of it, there is no re-action. The *re-action* may be ſuppoſed to be the ſame with the *reſiſtence* of a body at reſt; yet, they are inconſiſtent with each other, becauſe the *reſiſtence* is ſaid to be B proportional to the *maſs:* the *re-action* to the *action*, which different proportions of the ſame power, in the ſame body, are impoſſible, inconſiſtent with facts, and with each other, and are together, to be rejected.

c IF A BODY IN MOTION, RECEIVES AN IMPULSE, IT DOES NOT RE-ACT ON THE IMPELLING BODY; IF THE IMPULSE BE OPPOSED TO THE DIRECTION OF THE FIRST MOTION, THE IMPULSE OR ACTION IS RECIPROCAL; IF THE IMPULSE BE NOT OPPOSED TO THE DIRECTION OF THE FIRST MOTION, THERE IS NO RECIPROCAL ACTION, AND, IN EITHER CASE, THERE IS NO RE-ACTION.

A body in motion is active by reaſon of its motion; it can act or impel in the direction of its motion, and, therefore, a body impelling it, contrary to its direction, is, by it, reciprocally impelled. But this action on either, is the effect of the ſeparate ſtates of activity induced upon each body; neither action is conſequent upon the other action; therefore, neither is re-action, which is a conſequent action. When the impulſe is not oppoſed to the direction of the moving body, there is no reciprocal action; becauſe the moving body, though active, does not act againſt the direction of its own motion, and, in all caſes, actions are proportional to the activity of their own bodies, not to the action of other bodies.

IN IMPULSE BETWEEN TWO BODIES IN MOTION, EACH UNDERGOES AN EQUAL CHANGE IN A CONTRARY DIRECTION. D

Whatever motion either body imparts to the other, itſelf is deprived of, and retains ſo much leſs in the ſame direction as the other has more; the changes thus produced, are therefore equal, and they are contrary, ſince one body is accelerated, in conſequence of the others being retarded. E

IF ANY INVISIBLE FLUID SURROUNDS A BODY, PRESSING TOWARDS IT EQUALLY ON ALL SIDES, AND BY THIS EQUALITY ON ALL SIDES, PRESERVING THE BODY AT REST; AS THE FLUID X, X, X, ENVIRONING THE BODY M, FIG. 5. AND ANOTHER BODY (n) FIG. 6, APPROACHING TOWARDS M, BECOMES IMMERSED IN THIS FLUID, AND RECEIVES THE ACTION OF SUCH PART OF THE FLUID AS FALLS ON, OR ENTERS INTO IT, THE TWO BODIES M AND (n) WILL TEND TOWARDS EACH OTHER WITH EQUAL MOMENTA, AND IF AT LIBERTY, WILL, WITH EQUAL MOMENTA, APPROACH EACH OTHER. F

For the body (n) receiving the action of ſo much of the fluid as falls upon it, diminiſhes, on that ſide, in the ſame proportion, the preſſure upon M, and, therefore, M is no longer preſſed equally on all ſides, but moſt on the ſide (o), contrary to (n), where the preſſure is undiminiſhed. The body M, will therefore move towards (n), by the ſuperior preſſure on the ſide (o); at the ſame time, (n) being preſſed towards M, by the fluid, of which it has deprived M, will move towards that body; and the preſſure on (n) being preciſely that which is wanting to M, and which gives the ſuperiority to the ſide (o) of the body M, the momenta of M and (n) will be equal, and their velocities reciprocally on their maſſes.

OBSERVATION VII.

G If a piece of iron be placed within the action, which ſurrounds a magnet, and which, being equal on all ſides, preſerves the magnet at reſt; the iron, being acted upon by the ſurrounding influence of the magnet, both bodies, if floating in water, or otherwiſe at liberty to move freely, will approach each other with equal motions, and, in proportion, as either maſs is leſs, its velocity will be greater than the other.

EXPLANATION.

H Whatever be the particular theory, whereby all the phenomena of the magnet are explained, it is inconteſtible that ſome agency ſurrounds magnetic bodies, and actuates maſſes, or particles of iron, within its reach. There can be no doubt, but that the magnet is the centre, and the ſubject of this agency; and it is certain, that it influences the magnetic body equally on all ſides, otherwiſe it would, at all times, be moved, when left to itſelf, by its own magnetiſm. It is equally evident, that any given portion of the ſurrounding activity of a magnet, cannot at the ſame time, act upon two bodies; conſequently, if, at any diſtance from the body of the magnet, any portion of the ſurrounding agency, finds a new ſubject of its action, ſo much action is taken on that ſide from the magnet itſelf, the equilibrium is thereby deſtroyed, and the action on the contrary ſide, preponderates, by the quantity removed from the other. The ſurrounding agency is, in fact, ſtill equal on all ſides its own centre; but not on all ſides the body of the magnet. The centre of this agency is now changed, from the centre of the magnet to ſome point between that centre and the piece of iron; both bodies are now circumſcribed within one ſphere of activity, and though, at a diſtance, in reſpect to their viſible ſurfaces, they may be conſidered as one united body, in reſpect to their attachment (s, T 261); and the centre, common to both, is now the centre of the agency towards which both bodies move, and at which they will meet.

I The propoſition, may be equally well exemplified, and the fact remarked in all other caſes of an inviſible influence, between diſtant bodies; as in coheſion, in electricity, in gravitation, or in all thoſe phenomena to which the term attraction is applied, whether to expreſs the fact, or to denominate the cauſe; but which term, either as expreſſing the effect or the cauſe, we have thought it expedient to avoid, for reaſons above given.

K IF AN INVISIBLE FLUID PROCEEDS FROM ANY CENTRAL BODY, M, FIG. 7, AT THE END (f), AND PERFORMING A CIRCUIT, RETURNS INTO THE SAME BODY AT (g), AND A CONTRARY AND EQUAL EFLUX, CIRCUIT AND INFLUX, PROCEEDING FROM (g), AND RETURNING AT (f), PRESERVES THE BODY, ACTUATED AT ONCE BY THESE CONTRARY POWERS, AT REST, AND A BODY (n) BE PLACED WITHIN THE EFLUX OF THE FLUID AT (f), AND THIS EFLUX ONLY, ACTS UPON (n), THE BODIES M AND (n) WILL MUTUALLY RECEDE FROM EACH OTHER, WITH EQUAL MOMENTS.

For the body (n), by receiving the action of any portion of the circulating fluid, deprives the body M of the action of that part, and thereby deſtroys the equilibrium of M, by diminiſhing, on one ſide only, the ſurrounding activity. The iſſuing fluid from (f) remaining in (n), is prevented from performing its circuit and returning at (g); on the ſide (g), therefore, the preſſure on the body M is diminiſhed, by ſo much of the action as (n) ſuſtains; while, on the ſide (f), the other current (not deſcribed in the figure), proceeding from (g), enters undiminiſhed; the body M, therefore, being preſſed as uſual on the ſide (f), and having part of its equal preſſure at (g) removed, will begin to move towards (g), retiring from (n); while (n) retires alſo from (n), by the out-flowing current which it arreſts, and the current which moves (n), being the ſame, which is prevented from entering M at (g), theſe contrary motions muſt, neceſſarily, be equal.

OBSERVATION VIII.

The phenomenon of repulſion, correſponds with the foregoing propoſition and explanation. If ſimilar poles, North or South, of a magnet, are brought near together, they will recede from each other, with equal moments.

EXPLANATION.

An active influence, ſurrounding the magnet, acts at a diſtance from it. If a body be rejected from the magnet, this influence is directed alſo from the magnet; if the influence iſſues continually, the ſource muſt be ſupplied: the moſt ſimple, obvious, and natural ſupply, is a circulation of the ſame influence; if the iſſuing influence be found to recurvate backwards, towards the end, where the ſupply ſhould enter, and not to proceed continually from the magnet, its return into it is put out of doubt. That the influence does ſo recurvate, towards the contrary end of the magnet, is made to appear, by ſtrewing ſteel filings between two repellent ends of two magnets, placed near together: that the repelled body is actuated by portions of this out-flowing ſubſtance, demonſtrates that the influx, at the contrary end, is diminiſhed; for the portion that is employed in repelling the body, cannot, at the ſame time, be purſuing its courſe in the circulation: this fact, therefore, may be conſidered as completely in point to the propoſition.

N ALL ACTIONS HAVE A RELATION TO TWO BODIES, WHICH, BY THE ACTION, SUFFER CHANGES, EQUAL IN CONTRARY DIRECTIONS.

OBSERVATION IX.

O The fact is univerſally eſtabliſhed by experiments and obſervations, and needs no particular example here.

This propoſition is not to be underſtood, as P being the ſame with the third law of motion in the received theory, *that action and re-action are always equal and contrary.* This law appears, from what has been ſaid in the four preceding propoſitions, to be an erroneous hypotheſis to explain a general fact.

The changes, in all action, are equal and Q contrary in two bodies, but this does not proceed from a re-action to every action, or require that all action ſhall be mutual and contrary. In all caſes, a ſingle action, without any re-action, or mutual actions, ſerves to explain the phenomena; while the hypotheſis of re-action or mutual action, if admitted, is contradictory, even to appearances.

By recurring to the preceding illuſtrations, R (z 291, c, d, f, k, &c.) it will appear, that in all action, whether impulſe of bodies, or the action of ſurrounding fluids, the body acted on is a recipient of an active fluid; that another body is the ſource of that fluid, and is deprived of ſo much as it has imparted to the former; there is, therefore, in *one action* the *two changes,* equal and contrary, which the fact exhibits. If a fluid iſſues from a ſource into a receptacle, the former is exhauſted, as much as the latter is repleniſhed;

the action is one, but the change effects two objects, in a contrary manner, and in an equal degree.

s In ſome caſes, re-action is impoſſible, in fact, and inconſiſtent with the appearances; it is always unneceſſary, and in no inſtance proved.

T In all impulſe, it is impoſſible that any action on a body ſhould give birth to its own contrary and deſtroyer—all nature revolts at this idea, and all analogy contradicts it. It is inconſiſtent with the inactivity of body. If inactive in itſelf, it can act only by an acquired activity; but a re-action, contrary to the action acquired, muſt originate in the body itſelf, contrary to its alleged inactivity. It is inconſiſtent with the communication of motion; for, if this law were true, all motion would be deſtroyed in impulſe and none could be communicated; there would be an univerſal ſtagnation and repoſe wherever bodies met or impelled.

U Such would be the conſequence, if this law, celebrated ſo highly in the writings of philoſophers, had any place in nature. The contrary changes from whence a re-action is inferred, afford the proof againſt it, unleſs that ſelf-evident law be denied, that contrary and equal actions meeting, deſtroy each other; for if the actions be deſtroyed, they can produce no changes.

In actions, like thoſe termed attractive, because both bodies are moved, both are concluded to act; but this inference is not juſt, ſince it has been proved, that one action is ſufficient to the effect, and, therefore, two ought not to be admitted. X

There are ſome familiar facts adduced in ſupport of this law, which it would be inexcuſable not to mention. Y

" If you preſs a ſtone with your finger, the " finger is alſo preſſed by the ſtone." " If a " horſe draws a ſtone tied to a rope, the horſe " (if I may ſo ſay) will be equally drawn back " towards the ſtone." Here, one can only ſay, it is aſtoniſhing how far an hypotheſis can obſcure the cleareſt views of reaſon. Both the preceding aſſertions, are contrary to the cleareſt evidence, yet both meet a ready acceptance with the majority of men. The ſtone preſſes not the finger, nor does it draw back the horſe. In what is the animal ſtructure ſuperior to a ſtone, if the latter can return the action the former exerciſes? How do theſe actions appear? Z

Inſtead of a ſtone, let one finger preſs another, which returns the preſſure; let the horſe be oppoſed by another horſe. The obſtruction to motion will then evince the contrary actions—friction may, in like manner, prove an obſtacle—but let the ſtone be free, it will obey the impulſes of the finger and the horſe, and thereby prove that it re-acts not. The finger feels only its own preſſure; the rope tied to the ſtone is diſtended only by the action of the horſe; but if, as it is ſaid, the horſe is drawn to the ſtone, as much as the ſtone to the horſe, ſurely the ſtone may as reaſonably be expected to walk on and drag the horſe after it, as the horſe to get the better of the ſtone, theſe opponents being declared, in all reſpects, equal.

When in the Scholium, at the end of the firſt book[a], we find Sir Iſaac expreſſing himſelf thus: "I was only willing, by theſe examples, to ſhow "the great extent and certainty of the third law "of motion:" we are not to imagine, that ſo accurate an experimentaliſt raſhly pronounced, concerning a fact which he had not duly aſcertained. He has elſewhere expreſſed the fact unexceptionably, "that equal changes, were in "his experiments always produced towards con-"trary parts." Of the changes, the ſenſes and admeaſurements were the criterions; but his conſequence, immediately drawn, is erroneous, "that "the action and re-action were always equal." Here he aſſumes that in order to two contrary changes, two contrary actions are neceſſary; but we have ſhown that in the actions of a medium between diſtant bodies, theſe are unneceſſary, and in impulſe, where, if the contrary actions met, they would deſtroy each other they are impoſſible.

---

[a] Principia.

IF A BODY IN MOTION WERE EXPOSED TO NO OBSTACLE, AND SUBJECTED TO NO NEW INFLUENCE, IT WOULD CONTINUE IN ONE UNIFORM RECTILINEAL MOTION. B

We have no fact in direct proof of this propoſition; all bodies, that we can obſerve in motion, are both expoſed to obſtacles and ſubjected to new influences; but inaſmuch as bodies are diſpoſed, to continue in an uniform motion, and to move in right lines, except ſo far as new influences and obſtacles appear, facts may be ſaid to correſpond with the propoſition.

The firſt law of Sir Iſaac Newton expreſſes the rectilineal tendency of motion, and the perſeverance in motion, of bodies, once moved. But the cauſe, and the conditions are different from thoſe here aſſigned. An innate force is the cauſe; C cauſe; the conditions are, unleſs any new force produce a change. When a body is moved, a force or active ſubſtance is imparted to it; and the body continues to move, unleſs the efficacy of this force be counteracted by a contrary force imparted, or the body be deprived of the force, by its own impulſe on other bodies; two cauſes diminiſh or deſtroy motion; a new and contrary force, ſuffered, or the force of the body in motion exerted on ſome other: a new force impreſſed on the moving body, is not, therefore, the *only condition* of change in its motion, as the firſt law of Newton declares, nor is an *innate force* the cauſe of its perſeverance.

D. A BODY IN MOTION, MEETING WITH ANOTHER BODY IN ITS PATH, WILL COMMUNICATE MOTION TO THAT OTHER.

The body is moved by a ſubtile fluid, which, having motion eſſential to itſelf, has been accidentally imparted to the body, which, with the fluid, acquires its motive tendency. Any other body in the path of ſuch a motive body, and not diſpoſed to move with it, muſt be an obſtacle in its way, by reaſon of their mutual reſiſtence to penetration; but the ſubtile fluid, incapable of reſt, or having its eſſential motion deſtroyed, and eaſily pervading all bodies, paſſes on, out of the former motive body, into the obſtacle, to which it imparts its motion, and thus, in impulſe, motion may be ſaid to be communicated.

The fact of communication of motion, here E deduced from principles, being on the received ſyſtem inexplicable, is there conſidered as a miracle, or an effect not depending on any natural powers or laws; but what can more ſtrongly evince the imperfection of principles intended to explain natural appearances, than their failing in regard to a fact, of all others, the moſt frequent and familiar.

THE EFFECT OF A BODY IN MOTION, EXERTED F TO OVERCOME ANY UNIFORM FORCE OF GRAVITY, OR COHESION, IS PROPORTIONAL TO THE MASS COMPOUNDED WITH THE SQUARE OF THE VELOCITY; ALTHOUGH THE FORCE OR MOMENTUM IS IN THE RATIO ONLY OF THE MASS AND SIMPLY THE VELOCITY.

Almoſt infinite has been the perplexity, which this principle has occaſioned, ſince Mr. Leibnitz firſt announced it, but in too general a way, and the followers of Sir Iſaac Newton contended againſt it. The experiment is eaſily made.

OBSERVATION X.

Let a weight fall from a known height per- G pendicularly upon a nail, whoſe point is juſt inſerted in a piece of wood, and the number of ſtrokes be found, which the weight at that height requires to drive home the nail. If the weight then be let fall from a height double the former, one fourth the number of blows will drive home a nail of equal ſize and figure, in the ſame wood.

H The fact is an obvious conſequence of the principles by which action is explained. It is evident, that a projectile impelled againſt the flow of a current, will with a double velocity proceed four times the diſtance; for with the double velocity, it having a double motion, it will, by its double motion, be able to encounter a double quantity of the current. But by reaſon of the velocity being double, it will have proceeded double the diſtance of the former in an equal time, and in this equal time, it can have encountered a force of the current, equal only to that which the former projection had met in the ſame time and half the diſtance; for we do not here ſpeak of the quantity of the maſs of the fluent, but of its flowing impetus, which being ſuppoſed uniform, muſt always be equal in equal times, without any regard to the maſs or diſtance in which the impetus is conſidered. At the end of the double diſtance, therefore, the ſecond projection will have met as much of the impetus as the former met, and as much of its force will be deſtroyed as is equal to the former projection; but the force of the ſecond projection being double, will yet proceed on to another diſtance, alſo double the diſtance of the firſt projection, and thus the whole diſtance of the ſecond projectile will be quadruple the firſt.

It has been proved, that all action conſiſts in motion, and is, therefore, as a current, to have the time of its flow regarded in its meaſures. It is half in half the time, in double the time, double. I

While an increaſed velocity augments proportionally the force of a projectile, it diminiſhes in the ſame ratio the reſiſtence of the oppoſing force. Leibnitz miſtook, in ſaying the force of the body was increaſed according to the ſquare of the velocity. Its effect only is increaſed in that proportion, by the diminution of the reſiſtence; the force of the body being in the ſimple ratio only of the velocity, as the Newtonians juſtly ſay. One can hardly have any ſingle evidence of the truth of principles, more ſtriking, than their ſerving to demonſtrate, *a priori*, a fact, ſo important in mechanics, yet ſo perplexing to philoſophers as this has been. K

CHAP. III.

Agreement of Phenomena, with the Orbicular or Revolving Motion, of the ACTIVE SUBSTANCE, *which is the Conſtructive Principle throughout Nature.*

A THE ACTIVE SUBSTANCE, the primary fluid, the immaterial baſis of all material being, the *matter*, if I may ſo ſay, or component ſubſtance of the world, is conſtituted into the fabric of the univerſe by peculiar motions, in orbits, either in circles or in ellipſes of various forms.

B The truth of this has been placed out of doubt, by the cleareſt evidence of rational proofs; but it muſt be confeſſed to be a deſirable thing, to be able alſo, to afford ſome teſtimony of which the ſenſes may judge.

C Matter is an inactive being, which when immerſed in ACTIVE SUBSTANCE, will be moved by its motion; unleſs it be at once actuated equally, in contrary ways.

If, therefore, the ACTIVE SUBSTANCE does, when from contrary points it is determined to a centre, revolve in ſome orbit about that centre, this revolution ought to carry about, in the ſame orbit, ſuch bodies as are the ſeats of the revolving ACTIVE SUBSTANCE, if thoſe bodies are free to move, and not urged equally, and, at the ſame time, in contrary directions. D

If a ſolid body, be at once preſſed by other ſolids, in two, or in any number of contrary directions, there is, from every ſource of the preſſure, a flow of the ACTIVE SUBSTANCE into the ſource of the oppoſite preſſure, or a continued circulation produced by the contrary preſſures (P 260). But in this caſe, each body is the ſeat of contrary currents, and by theſe contrary currents, no one of them ought to be moved; therefore, in the mechanical preſſure of ſolid bodies, there can be no ſenſible motion of the bodies to evince the internal circulation of the active fluid. E

For every preſſure has its own diſtinct circulation, and the central body, preſſed by ſurrounding bodies, by that preſſure, coheres, F becomes one body with them, and cannot therefore move.

G If a portion of the active fluid be determined to unite in a centre within itſelf, there will be infinite currents concentrating as radii from the circumference to the centre; and in the fluid portion, all theſe currents will combine to give the whole portion one revolving motion about its centre, beginning at the centre, and extending towards the circumference.

H If a material fluid, air or water, be made to move from a circumference to a centre, the progreſs and action of the active fluid will be marked to the eye; for the concentrating ſtreams of the material and inactive fluid, are ſo many repreſentatives and ſenſible tokens of the inviſible fluid, which actuates and moves them.

I The parts of the fluid do not cohere, but are capable, in any part within the circumference, to receive a motion ſeparate from the motion of other parts; nor is the fluid, preſſed on all ſides to the centre, one body, united with and held to the preſſing bodies, as a ſolid preſſed on all ſides is: a fluid, therefore, is a fit ſubject to exhibit to the ſenſes as a ſenſible covering,

ing[a], the fact of the revolution of the inviſible active fluid, and in all fluids and bodies immerſed in them the fact ought to appear.

Hence we may lay down the following propoſitions. K

IF THE ACTIVE SUBSTANCE BE, ACCORDING TO THE CONCLUSIONS ALREADY DRAWN, MADE TO ASSUME A REVOLVING OR AN ORBICULAR MOTION ABOUT A CENTRE, IN WHICH ALL ITS PARTS ARE DISPOSED TO UNITE, ANY PORTION OF WATER, AIR, OR OTHER FLUID, WILL ALSO REVOLVE ABOUT ANY CENTRE WITHIN THE SAME PORTION, TO WHICH ALL THE PARTS ARE MADE TO MOVE: L

And converſely,

IF A PORTION OF ANY MATERIAL FLUID, ALL WHOSE PARTS ARE MOVED TOWARDS A COMMON CENTRE, DOES FROM THAT CENTRE, TOWARDS THE CIRCUMFERENCE, BEGIN TO REVOLVE ABOUT THE SAID CENTRE OF APPROACH, IT IS THENCE TO BE INFERRED, THAT AS THE MOTION OF THE MATERIAL M

---

[a] The immaterial fluid is embodied in matter, and is evident to our ſenſes, not directly, but through the medium of its corporeal companion.

FLUID TOWARDS THE CENTRE, WAS PRODUCED BY A SIMILAR MOTION OF THE INVISIBLE AGENT, SO, IN LIKE MANNER, THE CIRCULAR OR REVOLVING MOTION OF THE MATERIAL FLUID, DOES DEPEND ON A SIMILAR MOTION IN THE IMMATERIAL.

OBSERVATION XI.

N If, at the bottom of a veſſel of water, an aperture be made for the fluid to eſcape, it will revolve about the aperture, at, and at ſome diſtance from it, and eſcape with this revolving motion.

The water ruſhes from all ſides, in concentrating ſtreams, to ſupply the continual waſte at the aperture: theſe currents of water indicate the ſame central motions of the inviſible ACTIVE SUBSTANCE, and the revolving motion is alſo a conſequence of the revolution of the ACTIVE SUBSTANCE ſucceeding to its central motion.

OBSERVATION XII.

O If a fluid be agitated in a veſſel, by a body immerſed therein, ſo as to render the ſurface uneven, and to produce currents, in various directions, ſeveral vortices will appear in the fluid.

The fluid ruſhes centrically from the higher parts to the lower, to reſtore the equilibrium of the ſurface; or, ſtreams meet recurrent ſtreams; in either caſe, producing the effect, on the ſame principles, as in the laſt phenomenon. We cannot ſtir our tea without obſerving this fact; in every ſtream it meets our eye; in large bodies of water, or the ſea, encountring currents produce whirlpools, the terror ſometimes of navigators.

OBSERVATION XIII.

Concentrating currents of air ruſhing from oppoſite points, produce a revolving motion about the central point, or, a whirlwind.

It is agreed, among naturaliſts, that whirlwinds happen only where contrary winds meet from ſeveral points; they are found of various magnitudes and violence, according to the quantity and velocity of the central winds; at ſea, they form water-ſpouts; on ſhore, whirlwinds are ſometimes alarming and miſchievous; in windy weather we may frequently obſerve ſmall whirlwinds wherever obſtacles interrupt the regular currents of air and produce eddy winds, duſt and light bodies are carried round in ſmall circles, exhibiting in theſe familiar appearances, the univerſal law and conſtitution of nature.

Q A body, floating in any fluid, obeys the motions of the fluid, and is, in this reſpect, the ſame with a portion of the fluid equal to that which the floating body diſplaces; a body placed in the centre of any vortex of water, will be made to rotate on its axis; and if placed within the vortex, at a diſtance from the centre, will be carried about the centre together with the fluid. Theſe facts may eaſily be brought into view by ſmall vortices of water, ſuch as are found in currents, or as may in various ways be produced in veſſels (N, O 312), and may be diverſified at pleaſure, ſo as to exhibit ſome of the moſt important and intereſting phenomena in nature.

OBSERVATION XIV.

R The motion of the earth about its axis, being aſſumed as fact, is a ſublime and magnificent teſtimonial to our purpoſe.

S For the weight of bodies on its ſurface preſſing from every part towards its centre, does by our principles, afford the inference of a circulating fluid within; and the whole earth, with its atmoſphere, whether, as by our theory, it be ſuppoſed immerſed in the centre of a fluid vortex, or as by the received ſyſtem, to be ſurrounded only by a void ſpace, it is, on either ſuppoſition, equally at liberty to move and rotate on its axis; it ought, therefore, by the circumambient preſſure, which manifeſtly exiſts, to rotate on its axis, there being no impediment to ſuch motion; the ſame would obtain in ſmaller ſolid bodies on the earth's ſurface, when preſſed by ſurrounding ſolids, but that by the preſſure of the ſurrounding ſolids they become fixed, and united to them. Thoſe bodies alone, whoſe external ſurfaces are at liberty, can be made to rotate by the concentrating tendencies of all their parts. Such alone are bodies ſurrounded with fluids, or with a void, theſe are found in all caſes, actually to have ſuch a rotation; and the proof, ſo far as facts can go, is unequivocal and complete.

May we not juſtly draw from the above, a new and cogent argument for the truth of a theory which leads, *a priori*, to a demonſtration of the earth's motion on its axis. This important fact, hitherto known, only, as the ſlow reſult of aſtronomical diſcoveries, and, through ſo many ages, concealed from mankind, is a ſimple and obvious deduction from a juſt theory of mechanical motion.

Nor would it be difficult to extend the ſame method of deduction further into the machinery of the celeſtial bodies, but it would be foreign from our preſent buſineſs.

X And to thoſe, who would withhold their aſſent to the *proof* offered of the principle, we may now preſent to their ſenſes the ſame propoſition as the aſſertion of a *fact*, evident to all men.

Y I beg, however, that this appeal, on my part, to facts, may not be miſconſtrued into an acknowledgement that facts are proofs of truths, or that any *propoſition* can directly be proved by *facts.* A proof is a ſucceſſion of conſequences drawn from a truth admitted, ſhowing it to involve another truth, not admitted, until ſo proved. Theſe can exiſt only in the mind, and their ſubject is only general ideas. Every fact is particular, and exiſts without the mind. It is an individual exiſtence, which involves no other exiſtence than itſelf: more eſpecially a fact ſeen, can be no proof of another fact, unſeen, and unobnoxious to any ſenſe. Since then, the cauſes of phenomena are not the phenomena themſelves, they muſt be exiſtences not to be traced by corporeal organs, but by the intellect alone.

The facts above referred to, are ſenſible appearances of vortices in ſenſible fluids, water or air. Theſe facts are no proofs of other facts, they ſhow nothing beyond themſelves: when, therefore, we bring theſe as evidences to ſupport other facts, to wit, ſimilar, but inviſible motions of an inviſible fluid; that evidence is not contained in the facts adduced, but in a proceſs of the mind, which, admitting the fact ſeen, as an axiom or firſt principle, infers ſomething further, as neceſſary from the axiom, admitted. It infers from the effect, a cauſe adequate and preſent, and that can be no other than an agent, preſent in the material fluid, moving inviſibly, as the material fluid is ſeen to move.

But it is too much the wiſdom of the preſent age, to confine themſelves to coporeal methods of ſtudying nature. Experiment, alone, claims the philoſopher's regard. Having obſerved the ill ſucceſs of our forefathers, who, in their cloſets, abſtracted, and in profound meditation, endeavoured, by various proceſſes of reaſoning, to come at a knowledge of the ſecret cauſes of thoſe things, which the vulgar ſee with inattentives eyes; and concluding from their failure, not merely that they had reaſoned wrong, but that they were wrong in expecting that reaſon would avail them in this purſuit: the moderns attempt a different method, inſtead of their thoughts and their pens, they employ their hands and their machines. To the more common facts, they add a numerous liſt of others, leſs familiar, gathered from a variety of arbitrary aſſociations and conjunctions of bodies, which the pleaſure of the operator ſuggeſts. Theſe obſervations being made with inſtruments purpoſely calculated, the quantities of the reſults can often be aſcertained with conſiderable accuracy, and from hence much utility may accrue. But in all this, I can ſee no other hope than that of new facts continually multiplied by the indefatigable experimentaliſt. I ſee no advance towards the knowledge of cauſes. I cannot conceive how the cauſe of common appearances can be expected to be found in other appearances, leſs common and equally, or more obſcure. I can diſcern herein freſh labour, only, cut out for the philoſopher, but no aſſiſtance towards the attainment of his end.

I confeſs I am aſtoniſhed, when I ſee philoſophers of modern times pouring contempt on the ancients for the folly of hoping that reaſon would arrive at a diſcovery of the myſteries of nature, and commending their own ſuperior wiſdom in the happier method they have adopted, when I conſider what this method is.

That in the place of reaſon, they employ mechanical inſtruments, and ſubſtitute handicraft working for thinking.

Are the ſecrets of nature remote, that teleſcopes can bring them to us; are they ſmall, that microſcopes can diſcover them in their retirements; are they pent up in the innermoſt parts of hard bodies, that, hammar, chiſſel, and ſaw, can break their priſon walls, and let the captives free?

By force of mechaniſm, by tortures, do we A hope to drag from nature, the ſecret which ſhe reſuſes to our prayers.

After all, what has experiments done for us, B more than increaſe the catalogue of facts. Do we know more of cauſes than our predeceſſors? What, after all, can we expect? Will the cauſe we ſeek aſſume a corporeal form, and charm our ſenſes with unknown delights: will it be beauty to the eye, muſic to the ear, or ſweetneſs to the taſte; may we handle it; will the mathematician determine its figure; can we *keep* it; ſhall we treaſure up the precious novelty with the regalia of ſtate? And ſhould we, by ſome lucky hit, ſome exquiſite jumble of matter and motion, arrive at this deſired end, how long ſhould we be, before every branch of knowledge would adopt the experimenting plan! The mathematician would ſeek his *definitions* and *axioms* in the colliſions of bodies, and leave his *demonſtrations*

ſtrations for the more *certain* way of rule and compaſs; clocks and watches would be conſtructed to point out the moral relations and duties of mankind.

We ſhould ſeek a knowledge of the *firſt cauſe* in the ſame experimental way, and in the ſchool of nature (as the moderns ſay) ſtudy natures God. Some would ſeek him in the rude and boiſterous elements; others in the mechanic's ſhop, where the fetters of art lend their aid to ſubdue nature; the poliſhed mirror, the pervious lens, the wheeled machine, the force of mechanic powers would all be ſet to work in the pious cauſe. The chemical theologiſt by more ſubtile means, by alembic and retort, would ſeek to explore the latent deity.

I deſire not to abate the zeal for acquiring facts, nor decry their utility in their proper place. It is againſt the relinquiſhing for this, all other knowledge, and all other purſuits, that I proteſt; againſt the miſtaken zeal that explodes and brands with opprobrium, under the name of *metaphyſical*, all thoſe inquiries that alone can give utility to experimental knowledge. And when I ſee thoſe who call themſelves philoſophers, exulting in their error, glorying in their ignorance of that which only can be called philoſophy, and in that their enlarged knowledge of facts, which but ſerves to make the want of a juſt theory more conſpicuous; deceiving, thus, themſelves and poſterity; I hold it my duty, as a good citizen, and the friend of mankind, to declare theſe ſentiments without reſerve; nor to a falſe delicacy, ſacrifice the moſt important intereſts of truth and of the community. Neither in this declaration of my firm perſuaſion, can I allow that numbers, authority, or talents, are againſt me; the faſhion, indeed, is: but if to the many reſpectable names in the preſent day, who are convinced of its errors, I add the weight of all antiquity, I may hope to ſtand excuſed of arrogance or preſumption in joining my voice to ſo great a majority of the world, againſt the faſhion, however reſpectable, of a ſingle century.

CHAP. IV.

Select Propoſitions, abridged from the fore-going Pages, and ſeparated from their Proofs.

THE following ſelection of propoſitions from the foregoing work, as there maintained, with general references to the parts where they are to be found, may be uſeful, in ſome reſpect, as an index to the principal parts; but chiefly as exhibiting, in one view, the ſubſtance of the opinions, with their order, whereby the reader, who has gone through the arguments ſeverally, may have a collected view of the doctrines, apart from their proofs, and thus be more eaſily poſſeſſed of the ſubſtance of the work, and more competently, as well as more ſatisfactorily to himſelf, form his judgment upon the whole.

PROPOSITIONS.

▲ Senſations are the original ſources of all our knowledge (H 4).

Firſt principles exiſt in nature, and only in nature are to be ſought (I 4). B

Being concealed among more obvious qualities, they are to be ſought by analyſing thoſe things wherein they exiſt (L 5). C

Theſe are our ſenſations derived from the exiſtences about us (A 322). It is, therefore, by the analyſis of our ſenſations, we are to ſeek natural principles (M 5). D

Firſt principles are not objects of ſenſe, therefore, not to be ſought by experiment, but by the intellect alone (N 5). E

Principles obtained by reaſon are equally certain with facts (O 6). F

The ſecondary qualities of bodies are reſolvable into the idea of power (P 11). G

SOLIDITY ANALYZED, RESOLVES ITSELF INTO POWER OR ACTIVITY. H

Inactivity is a privation, and incapable of analyſis. I

K Matter is both active and inactive in different reſpects ; its component parts are active, and by their action conſtitute matter as an whole inactive (M 18).

L Inactivity has no relation to motion, but is its negation (O 18).

M THE ESSENCE OF BODY IS POWER (U 25).

N COHESION IS A POWER, WHICH, EITHER IN HOLDING TOGETHER ANY NUMBER OF PRIMARY SOLID PARTS, OR IN CONSTITUTING ONE PRIMARY SOLID, BY HOLDING ITS OWN PARTS TOGETHER, IS SIMILAR, BOTH IN ITS NATURE AND MODE OF OPERATION (N 25).

O The power of ſolidity is twofold, from within, outward, reſiſting compreſſure; from without, inward, preventing expanſion (E 29).

P MATTER IS NOT IMPENETRABLE (Y 37, &c.)

Q THE ANALYSIS OF THE IDEA OF MOTION RESOLVES IT INTO ACTION ALONE (P 48).

R ACTION DEPENDS UPON AND IMPLIES THE PRESENCE OF A SUBSTANCE WHICH IS ACTIVE (A 57).

S AN ACTIVE SUBSTANCE EXISTS THROUGHOUT NATURE, THE UNIVERSAL ESSENCE AND AGENT (S 61).

T This ACTIVE SUBSTANCE does actually exiſt, external to our minds, and independent on being perceived (Chap. vi. P 63).

U The ACTIVE SUBSTANCE is immaterial and unintelligent, intermediate to matter and mind (Chap. vii. P 84).

X The ſtandard of truth in philoſophy is the mind's perception of the connections of things (Q 98); hence rules of reaſoning (A 102).

Y THE MANNER IN WHICH THE ACTIVE SUBSTANCE IS ACTIVE IS BY MOTION (O 106).

Z THE MANNER IN WHICH IT ACTS IS BY UNION WITH THE SUBJECT OF ITS ACTION (T 107).

A NO RATIONAL AGENCY IS DISCOVERABLE, IMMEDIATELY IN EXPERIMENTS, BUT BY INFERENCES FROM THEM (P 112).

B BODIES AS ENTIRE MASSES BEING INACTIVE, THEIR ACTIVITIES ARE ADVENTITIOUS, NOT INNATE (A 113).

They

C They have two forms of activity, motion and impulſe (B 113).

D They are active by means of an ACTIVE SUBSTANCE communicated to them (H 115).

E THIS ACTIVE SUBSTANCE PENETRATES THE SOLID PARTS OF BODIES (M. 116).

F The quantity of activity is proportional to the quantity of ACTIVE SUBSTANCE (Q 117).

G IMPULSE DEPENDS ON ACTIVE SUBSTANCE FLOWING OUT OF THE IMPELLING BODY (R 127).

H MOTION DEPENDS ON THE ACTIVE SUBSTANCE RETAINED WITHIN THE BODY IT MOVES (S 128).

I ACTIVITY IS COMMUNICATED IN IMPULSE BY THE FLOW (G 326).

K Percuſſion is a mode of impulſe (I 326), marked by the change from the retained ſtate of the ACTIVE SUBSTANCE (H 326) to its flow, or it is the beginning of preſſure, or the mean ſtate between motion and preſſure (A 144).

L Preſſure is the laſt and complete ſtate of impulſe, and is when the flowing ſtate of the ACTIVE SUBSTANCE completely exiſts (B 144).

OUT OF THE IMMATERIAL ACTIVE SUBSTANCE MATTER MAY BE FORMED (C, D 148). M

Matter being at once active and inert in different reſpects (K 324) has, by its activity, a relation to immaterial active natures (F 149). N

The union of body and mind, is a fact in evidence of their mutual relations (X 156). O

Solidity conſiſts not in an inactive fulneſs (G 159). P

Denſity depends not on poroſity (I 160). Q

A MATERIAL ATOM IS FORMED BY THE ROTATION ABOUT ITS OWN AXIS OF A PORTION OF THE IMMATERIAL ACTIVE SUBSTANCE (C 166). R

The two effects, ſolidity and inertia, ariſe from one cauſe, a rotatory motion. In the modern ſyſtem, one effect motion, requires two cauſes, the impreſſed and innate forces (N 170). S

The relation between the ACTIVE SUBSTANCE and matter is reſembled to that between a line and a circle (O 171). T

The

U The modern philoſophy errs in attempting to prove powers or exiſtences by mathematical reaſoning (Z 173, C 174).

X It is an error to imagine that the Newtonian ſyſtem is founded upon mathematical reaſoning, or ſupported by it (C 174).

Y Its phyſical principles (or metaphyſical) are incapable of ſupport, but in their own merits (D 175).

Z PROBLEM PROPOSED TO EXPLAIN THE MANNER OF THE ATTACHMENT AMONG ATOMS (G 175).

A The difficulty which hitherto has attended this inquiry, has been of our own creation, by the falſe premiſes aſſumed (I 176, &c.).

B ATOMS ARE UNITED, OR COHERE BY INTERMIXTURE OF THEIR SUBSTANCES (A 183).

C THERE IS A SIMILAR LAW OF CONSTRUCTION, OR, AN ANALOGY BETWEEN ALL PARTS OF NATURE, THE SMALLEST AND THE LARGEST (Chap. vii).

BODIES CONTAIN WITHIN THEM ACTIVE PRINCIPLES, AND SOURCES OF ACTION, ALTHOUGH THEY ARE INACTIVE (P 228). D

MOTION IS THE ORIGINAL STATE OF BEING (L 229). E

REST IS DERIVED FROM MOTION (M 229). F

The orbicular motion, which conſtitutes matter and the rarer orbs, that retain the planets and connect the parts of the univerſe, ariſe from a law determining the motions of the ACTIVE SUBSTANCE to union, and from the neceſſity of exiſtence (Chap. iii. P 233). G

Coheſion is produced by imperfect atoms, called *connecting corpuſcles*, of the ſame nature with the primary atoms, compounded of parts of the atoms they ſerve to connect (Chap. iv. P 247). H

Mutual contary impulſes are tranſient unions produced by the ACTIVE SUBSTANCE, by means of its orbicular motion, whereby it produces all unions (Chap. v. P 257). I

The queſtion of the origin of motion implies an abſurdity; that death preceded and produced life (Chap. vi. P 263). K

4 An important difference between the law of union and attraction, is, that one is ſaid to be impoſed upon an immaterial active fluid, the other on, inactive matter, which latter is impoſſible, as it implies the ſame quality, activity, to be and not to be, at the ſame time.

CONCLUSION.

CONCLUSION.

HERE, for the preſent, I am compelled to cloſe a long and intereſting labour; under many diſadvantages, I ſubmit a faulty, and unfiniſhed work to the public award. Fully ſenſible how much I ſtand in need of indulgence, I am yet apprehenſive, ſome may think me leaſt entitled to it, in a point, where I reſt my chief pretentions to favour; I mean, in having given my own reflections, freely, without ſuffering them to be influenced, by what the world calls authority.

What will be the fate of this volume, time, only, can reveal; of this I am unalterably aſſured, every free diſcuſſion of eſtabliſhed doctrines, produces a double benefit to ſcience; as it aſſerts the independence of the mind, and tends to diſſolve the charm which eſtabliſhments, long unexamined, produce; while it continually brings them anew to the teſt of reaſon, and gives us the chance of diſcovering errors, which our predeceſſors may have overlooked.

Divine revelation, alone, can have a claim to an independence on reaſon. Whether thoſe are worſe philoſophers, or theologiſts, I know not, who would place philoſophy on the ſame footing.

Nor is it admiſſible, as theſe contend, that *what has once been proved to be true, muſt ever be ſo*; deſigning, thus, to perſuade men, that none need again examine what *they* have reported as true. For what is proof? It is that which ſatisfies the mind of truth. It is an evidence adapted to the ſtate of the intellect. The ſame thing will, to one man, be demonſtration, and give full aſſurance, which, to another will not amount to probability. Would not the followers of Ariſtotle, or of Des Cartes, aver, they have proofs of their doctrines; and if what has once been proved true, muſt ever be true, our ſyſtem, each would ſay, muſt be eternal.

To what then does a principle lead, which will apply alike to every ſyſtem, and every ſect.

The truth is, the votaries of every different philoſophy, and different worſhip, are themſelves perſuaded in their faith; but this argument can only avail to the predominant party. When Carteſianiſm was the vogue, would not they have ſaid what the Newtonians do now. Had the argument been then allowed, the ſyſtem of Newton would never have prevailed—ſhould it be now allowed, Newtonianiſm can never be reformed.

Dulneſs will affix the ſeal of infallibility to the orthodoxy of the day. It will bar the door of ſcience upon mankind, and blaſt the riſing hopes of all poſterity.

What glorious advances in knowledge, futurity may have in ſtore, we know not; but ardent ought to be our hopes, and indefatigable our zeal; we ought to preſs forward, nor imagine the labours of *one man* can have bounded our progreſs, nor hearken to thoſe, who, having erected an idolatrous temple to *his* fame, would have us *ſtop and worſhip*; nor preſume to paſs the boundaries they have marked out to human reaſon.

Let theſe boaſt of their proofs and enjoy them; let us demand their production, and judge of them for ourſelves. Proofs to paſt ages are not proofs to the preſent. As the mind gets enlightened and emancipated, its powers are ſtrengthened, its viſual organs emit a brighter ray. In things we deem proved, poſterity may diſcern errors. Thus we may go on from age to age, advancing to a more mature and perfect period than imagination can yet conceive.

Abſolute proof, indeed, is ever the ſame, but of this we have no knowledge. It is only with proofs, *relative* to our own intellects, that we are concerned.

Permit me now to caution thoſe engaged in ſcenes of active life, from the dangerous error of imagining that metaphyſical inquiries; that the firſt and abſtruſe principles of things are, to them, of ſmall importance. Arts, manufactures, commerce, laws, government, civil policy, the order and happineſs of ſociety, are the reſult of knowledge and ſcience, muſt partake in their improvements, and together with them, make advances towards perfection, or ſink again into barbarian darkneſs. The deareſt intereſts of mankind are involved in thoſe inquiries we ſo little eſteem. The fate of poſterity, in theſe reſpects, is in our hands; we may cheriſh the ſeeds from which the riſing generation may reap a plentiful harveſt of knowledge, or we may choak the ſoil and leave only barren fields for their inheritance.

The connection, indeed, between metaphyſics and the concerns of life, lies too deep to be ſeen by ſuperficial obſervers; but the deeper and more concealed is the influence, the more potent and extenſive are its effects. A ſubterraneous expanſion of fire, if near the ſurface, ſoon makes its harmleſs exit; but if deep ſunk, near the centre, it ſhakes half the globe, and buries nations in ruins.

Had I foreſeen, the fatigue and the inconveniencies to which my preſent and its conſequent occupations have ſubjected me, and to which they will yet expoſe me, in one collected view, I am not certain whether my fortitude would have ſupported me in the undertaking. I have been led on by inſenſible degrees to the preſent moment; my deſire of information prompted me to think; my wiſh, both to benefit others, and to profit by their aſſiſtance, induced me to communicate my thoughts.

They are now no longer mine, but the propriety of the public and of mankind. If they tend to a growth in truth, I ſhall rejoice in having contributed to the public treaſury of ſcience; if they be the offspring of error, I ſhall concur in conſigning them to oblivion. We ſhould be cautious, equally, neither to hoard up baſe coin, nor throw away ſterling riches;

we ſhould examine with care, and ſelect with impartial hand.

As I have ſpoken freely of the opinions of others, others are at liberty to do the ſame of mine. Although I have ſought to detect errors, I have no pretentions to be exempted from erring. But, if I have written with candour, as I have examined with care, the like care and candour others will obſerve to me, in their endeavours to correct my faults, which, I hope, all, who have the proper talents, will be more aſſiduous to amend, than ſevere to cenſure.

BRITISH MUSEUM

F I N I S.

Fig. 1.

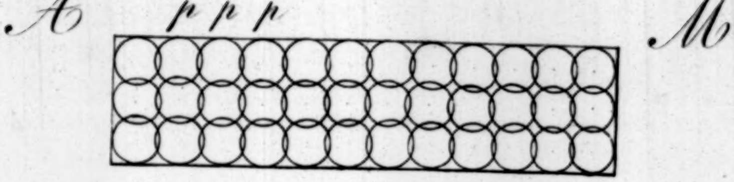


Fig. 2.

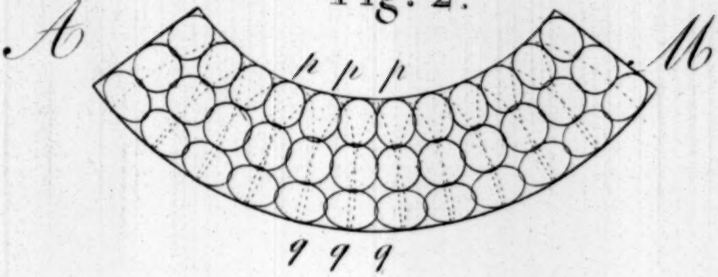


Fig. 3.

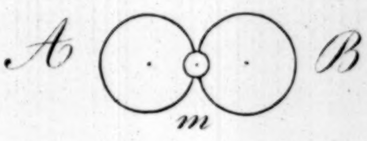
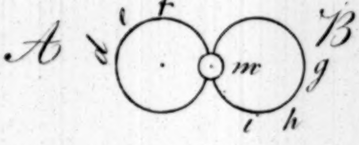


Fig. 4.



BRITISH MUSEUM

Fig. 5

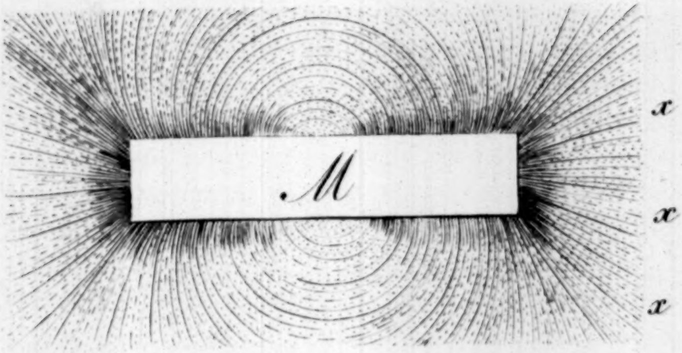


Fig. 6

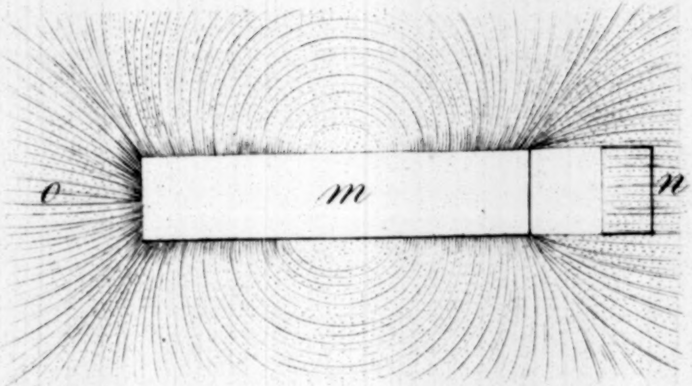
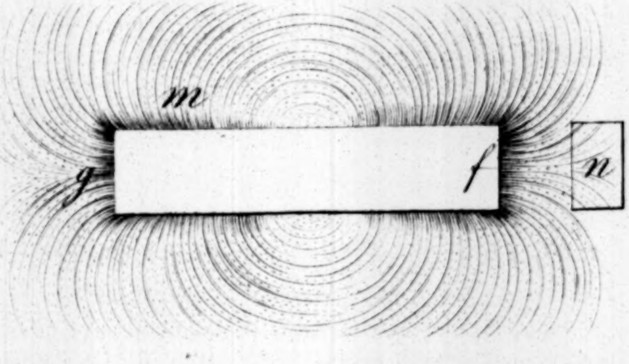


Fig. 7



BRITISH MUSEUM